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AD609582

Spacelabs, Inc.

15521 LANARK ST., VAN NUYS, CALIFORNIA

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II

III

IV

FINAL REPORT

V

DYNAMIC MEASUREMENTS OF PROTECTIVE MASKS

VI

VII

PREPARED FOR:

EDGEWOOD ARSENAL
EDGEWOOD, MARYLAND

PREPARED BY:

SPACELABS, INC.
15521 LANARK STREET
VAN NUYS, CALIFORNIA

BY: ROBERT N. SATO
PROJECT ENGINEER

SR 64-1014 (7200)
CONTRACT NO. DA18-108-AMC-228(A)

DECEMBER 5, 1964

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LIST OF ILLUSTRATIONS AND APPENDICES

I INTRODUCTION

This document is the last of a series of progress reports detailing the work accomplished under Contract DA18-108-AMC-228(A) awarded by Edgewood Arsenal to Spacelabs. The program carried out under this contract led to the development of a system capable of detecting and measuring pressure and flow conditions existing within a protective mask worn by subjects under dynamic operating conditions.

The purpose of this final report is to summarize the work performed under the contract, to describe the features of the resulting system, and to present recommendations for further work. Included with this document as appendices are engineering documents defining the circuitry employed in the mask electronics and the test procedure employed in the final evaluation of the system.

Work was initiated during the month of June 1963 and was concluded in December 1964 with the delivery of equipment to the Arsenal. This equipment consisted of two complete portable equipment sets consisting of mask electronics and portable back pack together with a ground receiving station capable of receiving and storing telemetered signals from a total of ten portable equipment sets.

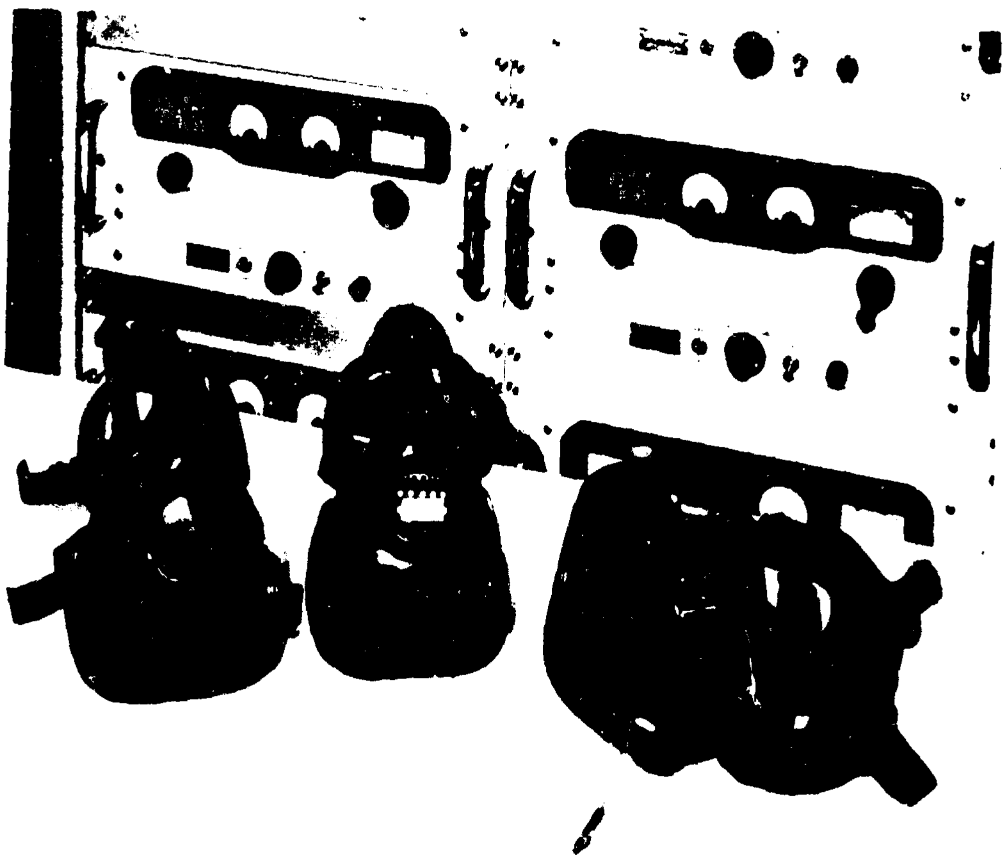
II SYSTEM DESCRIPTION

The system permits the measurement of certain specified conditions existing within a protective gas mask while the mask is being worn by test subjects remotely located in an operational exercise. The data measured by the system are mask compartment pressure existing within the mask and respiratory flow. The information is converted to an electrical signal, and conveyed by means of FM transmission to the ground receiving station for immediate readout or indefinite storage in a memory device, such as a tape recorder.

The complete gas mask system supplied by Spacelabs, Inc., comprises a number of units. The gas mask with electronics module is shown in Figure 1. The back pack, containing an FM transmitter and batteries to supply power, is shown in Figure 2. The two consoles, comprising the ground receiving station, which include discriminators, FM receivers, the Brush Oscillograph recorder, and tape recorder may be seen in Figure 3. Figure 4 shows the transducer, pneumotachometer and battery charging cable for the system.

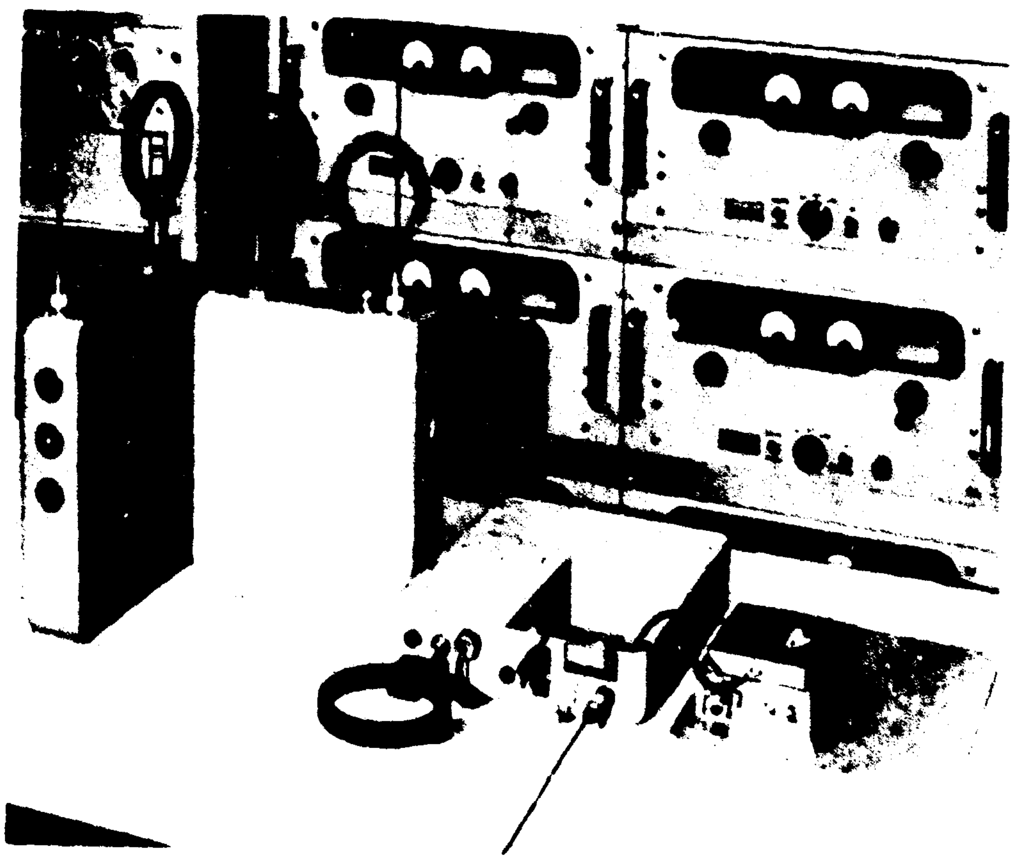
Demonstration of the system in the presence of both Arsenal and North American Aviation representatives, together with subjects wearing the gas mask system, was performed at Spacelabs, Inc., under the supervision of the company engineers on November 16, 1964. Following this demonstration, the complete system was delivered to the Arsenal at Edgewood, Maryland.

Prior to this demonstration and the completion of the project, each gas mask system had gone through the acceptance test procedure originated by Spacelabs, Inc., on the basis of the specifications set forth in the Statement of Work.



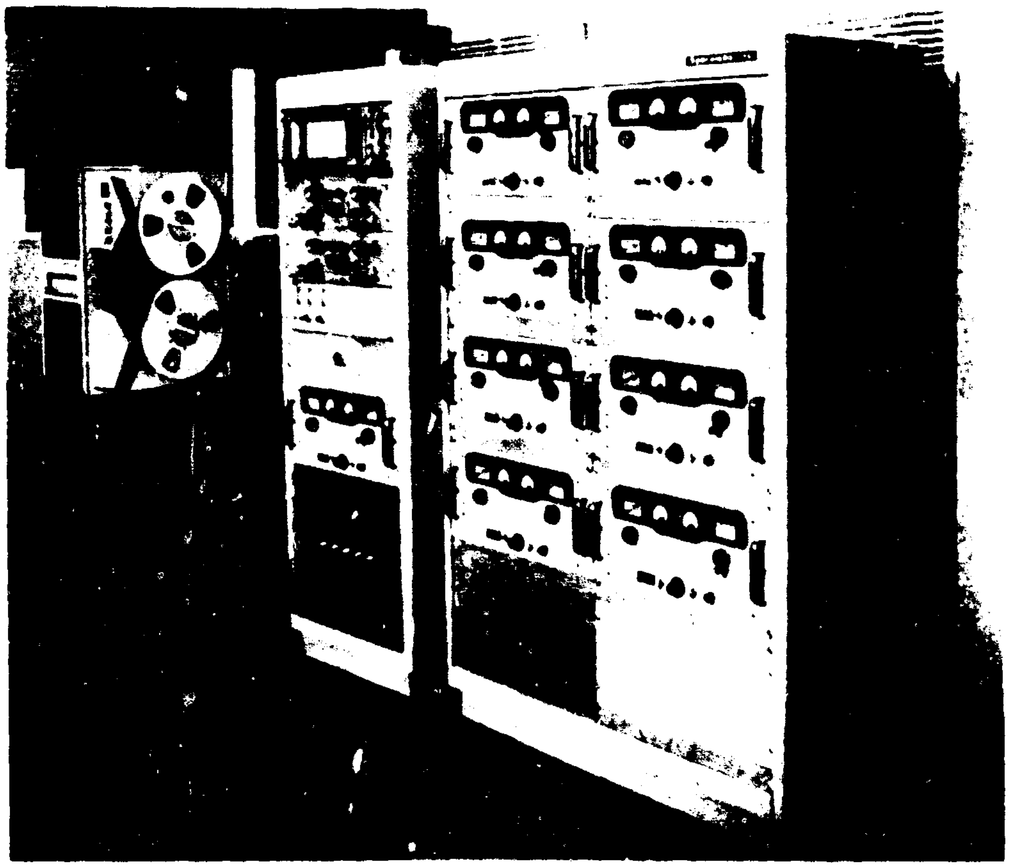
GAS MASK WITH ELECTRONICS MODULE

FIGURE 1



BACK PACK

FIGURE 2



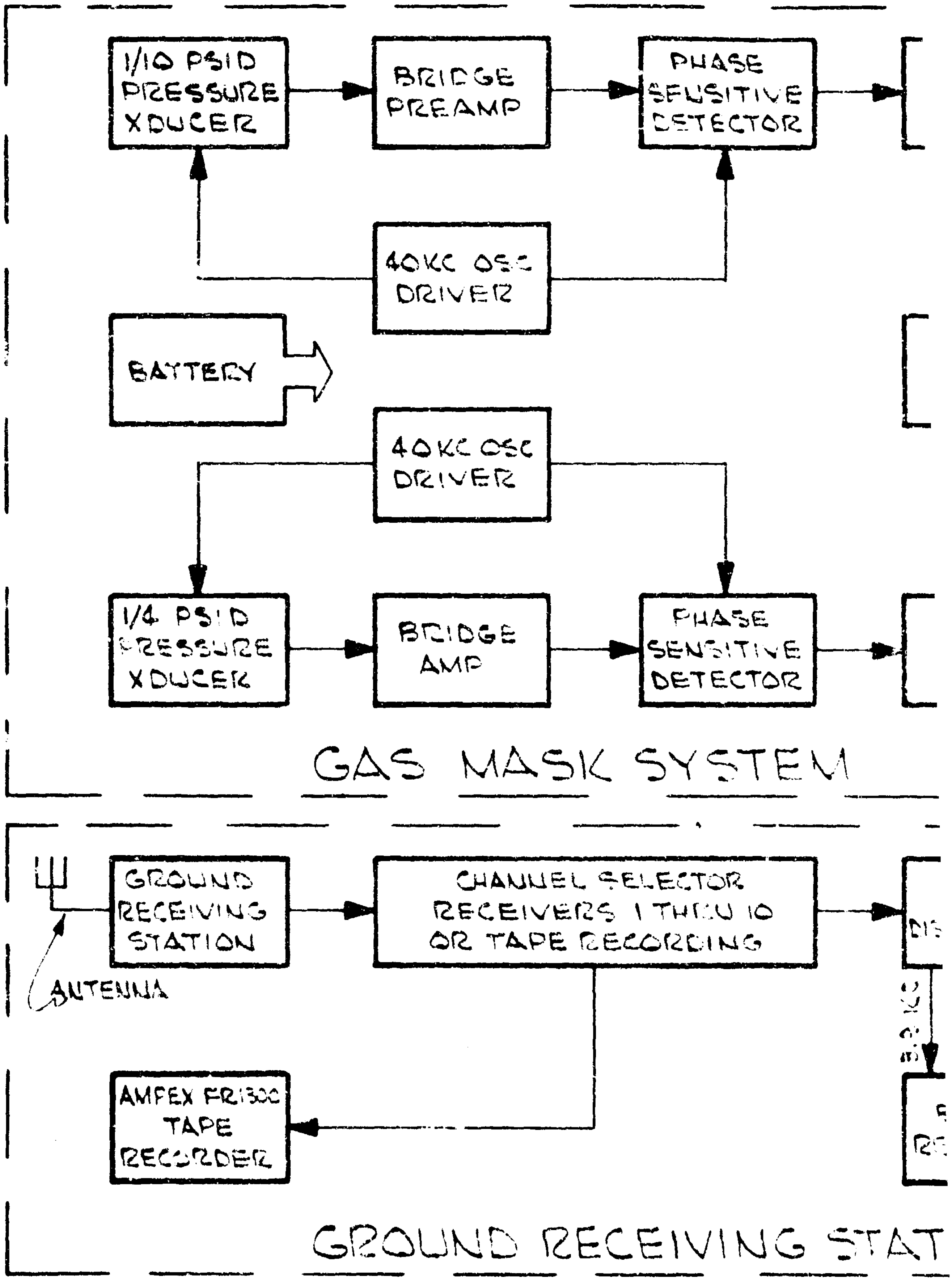
GROUND RECEIVING STATION

FIGURE 3

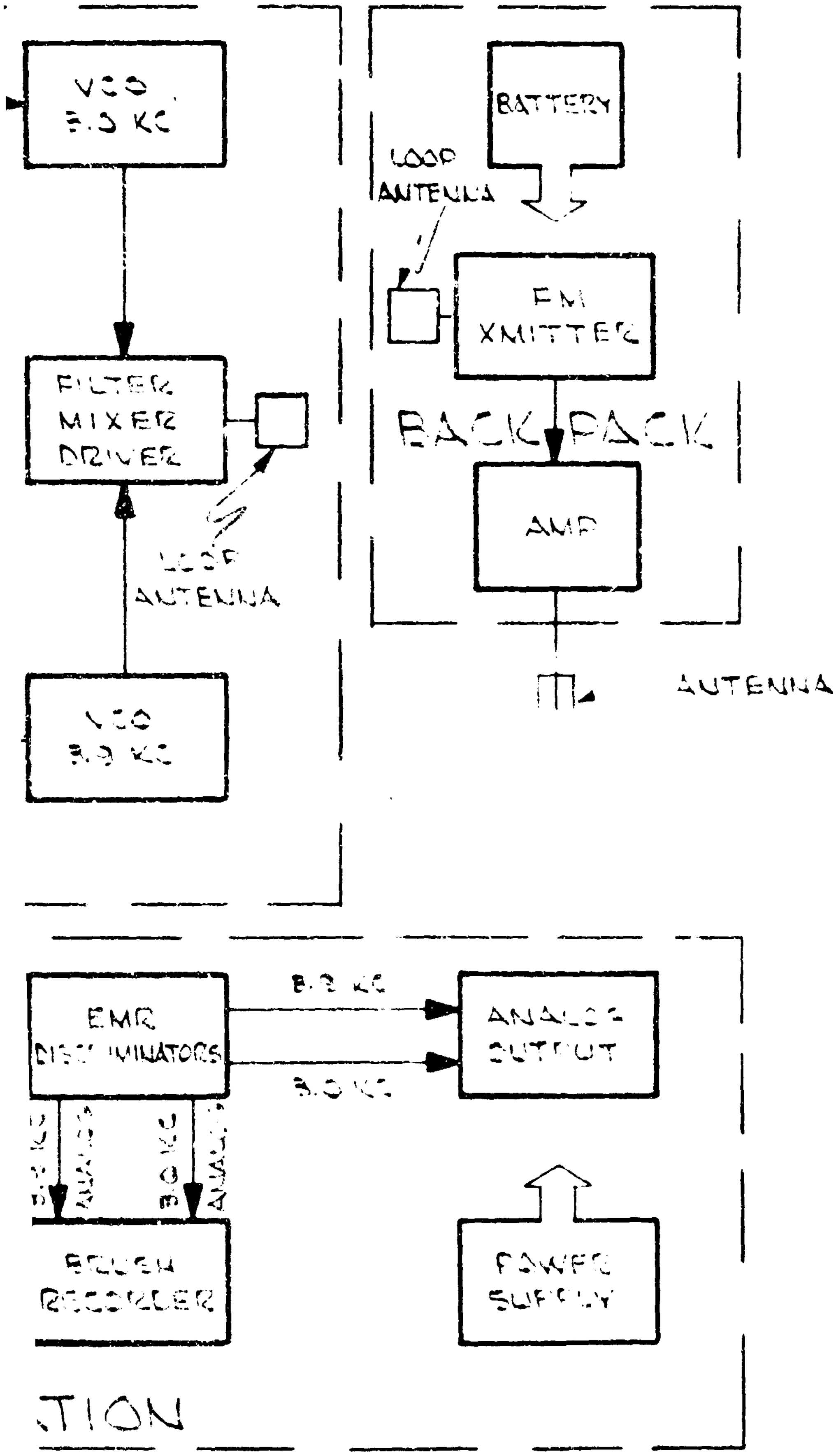
BATTERY CHARGING CABLES

FIGURE 4

For information purposes, the acceptance test procedures are included at the end of this Final Report. The system is considered to be a research oriented development device, and, due to the close communication between Arsenal and company representatives in regard to the system operational methods, the report contains no operational instructions. In order to systemize the technical discussion and the contents of this report, the overall block diagram, Figure 5, describing its functions is included here, together with electronics schematic diagrams. The report also includes some recommendations and conclusions.



SYSTEM BLOCK DIAGRA



AM FIG. 5

Spacelabs, Inc. 15521 LANARK ST. VAN NUYS, CALIFORNIA DWG NO

III MASK ELECTRONICS

An excitation voltage of approximately 40 KC, generated by a constant frequency oscillator in the mask electronics module located in the gas mask, is applied to both the variable inductance bridge of the transducer and the input of the phase sensitive detector. The transducer used in the system is manufactured by the Hidyne Instrument and Engineering Company. This pressure transducer is of the double coil variable reluctance diaphragm type, and is generally used for both static and dynamic pressure measurements. The system measures two pressures: respiratory flow of a subject wearing the mask, and compartment pressure. The 1/4 psi transducer senses the pressure difference between the inside of the mask and the atmosphere. The 1/10 psi transducer measures pressure difference developed across a pneu tachometer. The latter registers the pressure difference between the ir .e of the mask and the respiratory pressure of the subject as he breathes through it. Typical specifications of the transducers used in the system are in Figures 6 and 7. The transducer bridge circuit is coupled to the bridge amplifier, whose output is fed into the phase shift sensitive detector. Both amplitude and phase of the output voltage at the bridge network is a function of the pressure applied to the transducer input. Amplitude and phase changes a-e detected in the phase shift detector, filtered in a simple RC network, and applied to the Voltage Controlled Oscillator (VCO), whose frequency varies with respect to the center frequency. The center frequencies generated in the mask electronics, as seen from Figure 5, are 3.0 KC for the 1/10 psi channel, and 3.9 KC for the 1/4 psi channel. The composite of 3.0 KC and 3.9 KC is fed to the loop in the nose of the mask, which is inductively coupled to a receiving coil on the back-pack.

The bridge network operating with the transducer acts as a bandpass network

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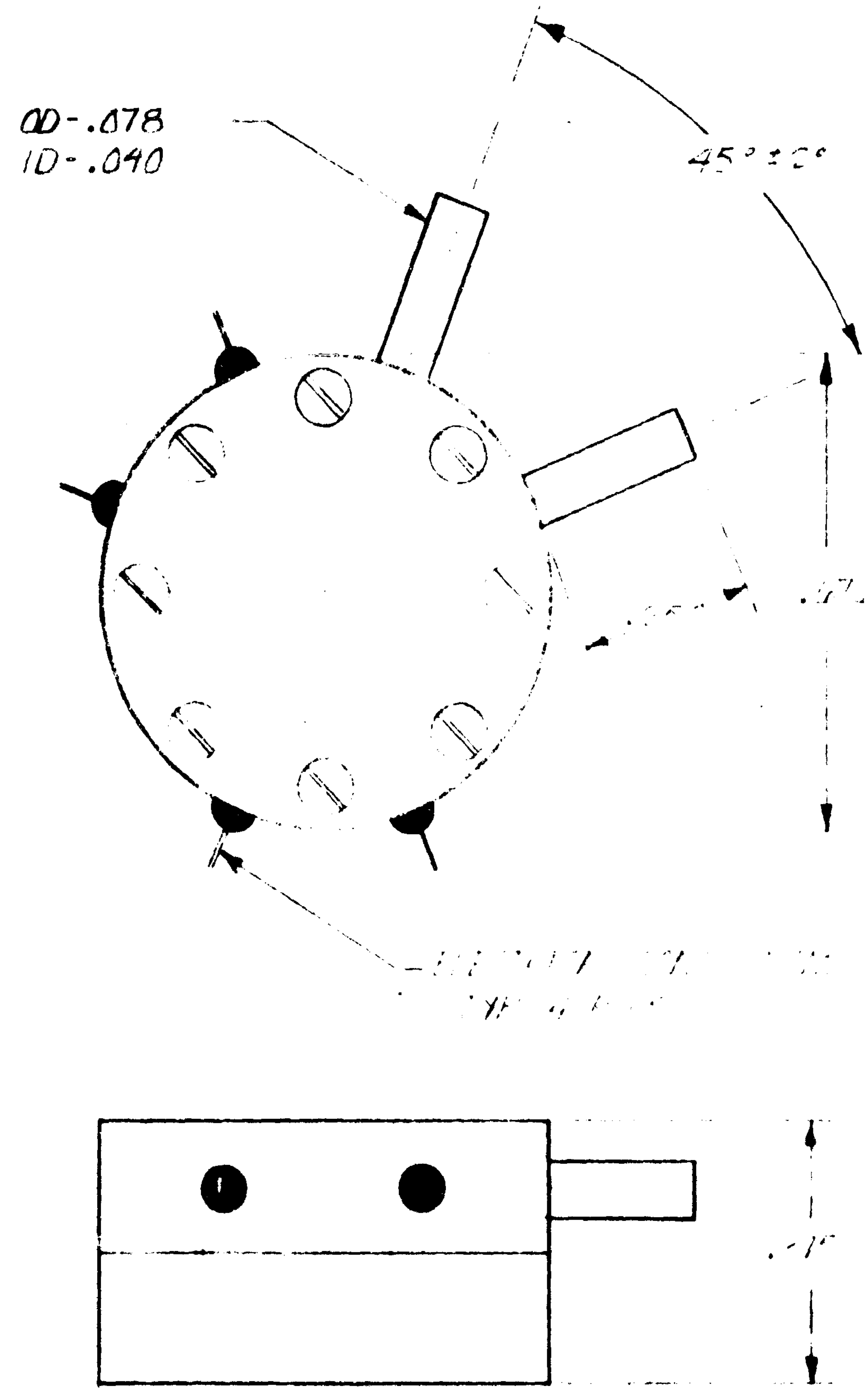


PRESSURE TRANSDUCER

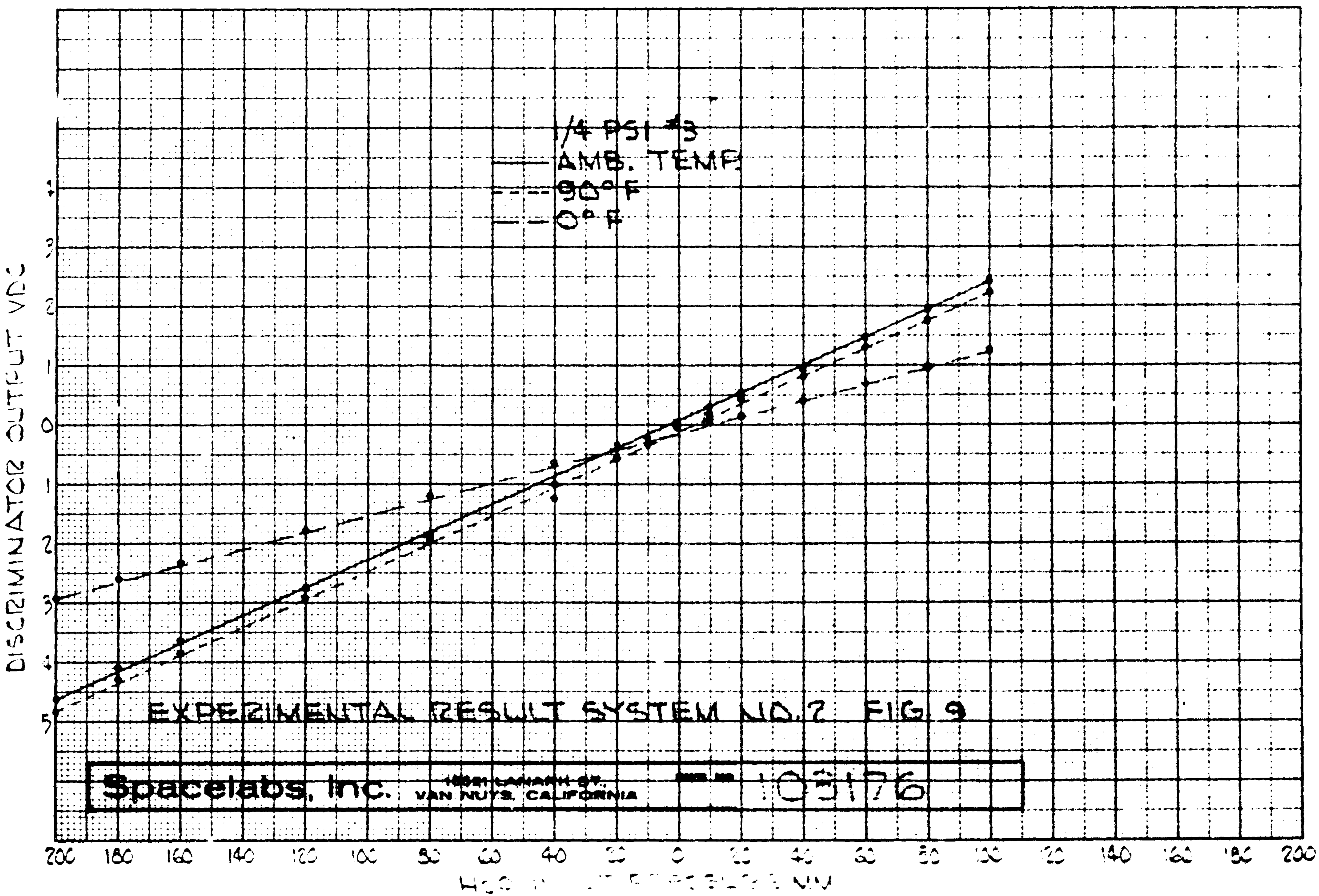
FIGURE 6

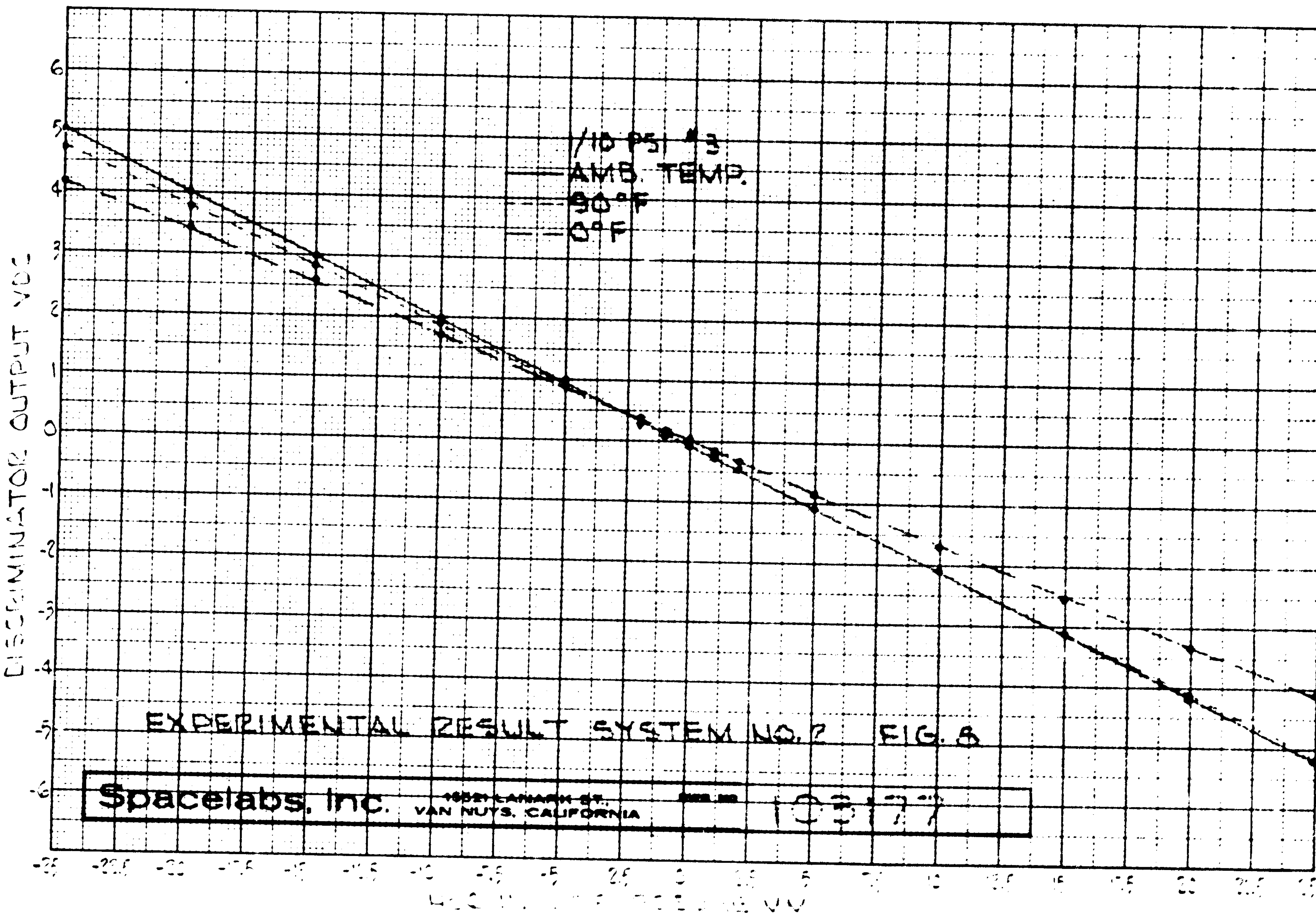
PRESSURE TRANSDUCER SPECIFICATION

Hidyne Model W-1/10D, Modified

1.	Weight	13 grams
2.	Dimensions	Per Spacelabs specification, i.e., 45°, pins rotated as per sketch.
3.	Excitation	5 vrms at 20 KC.
4.	Range	1/10, 1/4, 1/2, 3, 15, 30, psid.
5.	Output	30, 40, 50, 100, 150, 150 mv. per corresponding range above.
6.	Linearity	± 1% best straight line.
7.	Hysteresis	1% full scale.
8.	Maximum overload without damage	1 atmosphere for lower ranges, 50 psi all other ranges.
9.	Diaphragm natural frequency	Approximately 1.7 kilocycles for 1/2 psid range.
10.	Material	Type 416 Stainless Steel with epoxy potting.
11.	Pressure connections	1/16" plastic tubing fittings.
12.	Response	Less than 1 millisecond for 2 psia step.
13.	Internal volume	0.00112 inches ^{3}.
14.	Acceleration Error	2×10^{-3} cos Ø psi/g maximum (Ø = angle of attack relative to parallel with diaphragm axis).
15.	Output impedance	153 ohms at 64° phase angle.
16.	Power input impedance	39 ohms at 64° phase angle.
17.	Capacitance (coil to case)	25 pico farads
18.	Temperature Characteristics	Zero shift with temperature: 0.03% f.s./°F Sensitivity change: 0.03% f.s./°F
19.	Operating Temperature Range	-10 to +100°F

FIGURE 7


1/4 PSI #3
AMB. TEMP.
90°F
0°F
DISCRIMINATOR OUTPUT VDC
EXPERIMENTAL RESULT SYSTEM NO.2 FIG 9
Spacelabs, Inc.
VAN NUYS, CALIFORNIA
103176



DISCRIMINATOR OUTPUT VDC
1/10 PSI #3
AMB. TEMP.
90°F
0°F
EXPERIMENTAL RESULT SYSTEM NO. 7 FIG. 6
Spacelabs, Inc.
VAN NUYS, CALIFORNIA

as will be seen from a more detailed explanation at the conclusion of this section. Because of this action, the output voltage obtained varies in both amplitude and phase. All oscillators in the system provide square waves which are filtered and converted to sinusoidal waves. The active devices incorporated in the system are solid-state, and the circuits are well temperature-compensated to prevent change in oscillation frequency and a resulting non-linear readout signal over a range of ambient temperatures. When the ambient temperature stays constant, say 40°F, or 70°F, the linearity of the whole system would also stay constant, but the rate of change in the output voltage as a function of the pressure depends upon the operating temperature. A change in ambient temperature necessitates recalibration to adjust the scale factor relating output voltages to pressures applied to the input. The above is illustrated in Figures 8 and 9, taken on system #3. The #3 gas mask system was placed in the temperature chamber, and constant temperature was maintained during the measurement, while varying pressures were applied to the input. Voltage readings were taken at the output of the discriminator at the ground station.

Again referring to Figures 8 and 9, the chamber temperature change has very little effect on the output voltage with zero pressure applied. Any change in the output voltage may be due to a number of factors in addition to the transducer reactance. These include changes in oscillation frequencies, gains of several amplifiers, and active filter circuit components. The major effect is due to changes in both transducer reactance and oscillation frequencies, the latter being susceptible to variations in the supply voltage. Despite the number of factors involved, changes in the output voltage at the different temperatures

are seen to be well within the performance specification. The data also indicates the possibility of obtaining a constant slope, regardless of the variation of temperature. However, obtaining a temperature invariant slope requires trial and error adjustment of several potentiometers in the e.isting system. If the latter adjustment is not attempted, system performance is very much as indicated in the data in Figures 8 and 9.

To meet the performance specifications called for in the contract, the present gas mask system utilizes many passive and active components in the electronics circuitry. Packaging all of the components in the limited space available posed many problems. Difficulties which had to be contended with included overcoming of stray intercircuit capacitances, heat dissipation of active devices, limited availability of components of the proper size, etc. In many cases, it was necessary to choose expensive components over ordinary ones, due to considerations of size and performance. The 1/4 psi transducer along with the components of the bridge oscillator and amplifier circuits, are all contained in the nose cup electronics, and posed a difficult space problem. The circuitry is all welded construction, is permanently potted in epoxy resin and is packaged in such a way as to achieve maximum density, while maintaining maximum isolation between critical circuits. The availability of low value, high resolution potentiometers for use in the bridge was extremely limited, and it was necessary to use a higher value of potentiometer shunted with a low value resistance to improve linearity at the sacrifice of sensitivity. The sensitivity of the bridge null represents a problem in the final system and in any future work additi^^al effort should be expended in this area in order to facilitate operation of the system.

The mask electronics has an operating period of approximately three hours for each complete charging of the batteries. The power for the mask electronics is provided by nickel cadmium rechargeable cells located in the mask. Due to the low impedance of the pressure transducer, considerable power must be delivered to the bridge in order to maintain its sensitivity. Available space prevents using batteries with larger capacity. Therefore, the operating period of the system is limited to approximately the three hours.

As an alternative approach, transmission of the signal to the back-pack may be accomplished with a direct wire connection instead of the magnetic coupling employed in the present system. This would permit the entire mask electronics to be removed from the gas mask, and placed in a carrier pocket on the back-pack. The back pack thus would supply all the power to the mask electronics and the composite subcarrier signal would be fed directly through this cable to the modulation amplifier in the back pack. Operating the system in this manner would require extending the length of the bridge excitation cable to the 0.1 psi transducer which is located in the mask, and connecting flexible tubing between the pressurized mask interior and the pressure transducer located in the mask electronics on the back pack carrier. This approach would not only eliminate the packaging problem, but would also increase operating time of the system between recharges. The existing system developed by Spacelabs is a product of excellent technology and advanced manufacturing processes. However, if development of similar systems were to be undertaken in the future, it would be advantageous to devote consideration to certain areas in the system.

IV BACK PACK

The signal received at the loop antenna, coupled from the mask electronics, is fed to an FM transmitter. The FM transmitter operates with true frequency modulation, at a minimum radiated power of 1 watt. The transmitter is completely solid state, with a crystal stabilized reference oscillator assuring frequency stability within 0.001% of center frequency. Filters are provided to suppress spurious radiation well below levels where intermodulation with other equipment and spurious receiver responses can impair quality of transmitted data. The modulation frequency range is flat within 3db from 20 to 300 KC, assuring more than adequate capacity for the subcarrier frequencies employed. There are two adjustments provided on the FM transmitter. Access is provided through tuning ports in the sides of the case. The transmitter employs silicon transistors, and is enclosed in a rectangular aluminum case, pressure sealed by an "O" ring in the aluminum cover.

The system provides for the tuning of each FM transmitter to the desired frequency. The frequency range of the FM transmitter is between 230 and 260 megacycles. The back pack operates satisfactorily over the temperature range and requires no adjustment other than the initial modulation amplitude adjustment. Power for the FM transmitter and the modulation amplifier is provided by 23 size F nickel cadmium batteries connected in series. These batteries will require recharging after each 8 hours of operation. Instructions for recharging the batteries are contained in the end of the report.

The entire back pack electronics with the exception of the FM transmitter has been potted. This is to prevent the accumulation of moisture in adverse environment. The 23 size F nickel cadmium cells were potted in a foam

material up to about 85% of the volume in which they are contained. The remaining portion was potted with an RTV rubber. The section which houses the modulation amplifier, the power regulator for the mask electronics when used in the hard wire operation, and various of the electronic parts are potted in RTV silicon rubber. In the transmitter compartment of the back pack there is a battery clip for a 1.4 volt mercury cell. This mercury cell provides the -1.4 volts for the mask electronics when it is used in hard wire operation. A battery can be left in this socket without drain indefinitely. The only time the battery is connected into a circuit is when the hard wire cable is connected between the back pack and the mask electronics. Since this battery is required to produce very small amounts of power, it will not be necessary to replace this battery every time the back pack is recharged. The battery voltage should be measured under a load of 0.5 milliamps of current to determine that the voltage is, in fact, 1.25 to 1.4 volts. When the battery drops below 1.25 to 1.2 volts, it should be replaced. Due to the power dissipated in the back pack during normal operation, the temperature in the back pack should not drop below the minimum voltage under which the battery will operate. Therefore, no trouble should be experienced with a 1.4 volt battery under temperature. For information purposes, electrical specifications, environmental conditions, physical characteristics, and alignment procedures of the FM transmitter are appended to the final report.

V. GROUND RECEIVING STATION

The Ground Receiving Station consists of 10 NEMS Clark Receivers, a multi-coupler, a Brush strip chart recorder, a tape recorder channel selector, and a 3.0 and 3.9 KC EMR sub-carrier discriminator. The analog outputs from the EMR discriminator are made available on the front of the console. There is space available for 8 more discriminators for future use. There is a NEMS Clark receiver for each of the portable back packs. The receiving console provides the means for selecting any one of the multiplexed signals transmitted by each back pack, and either stores the sub-carrier frequencies directly on the tape, or reads the discriminated analog output on the strip chart of the Brush Recorder. It also provides several output jacks for the purpose of displaying the analog data on any available laboratory equipment.

To energize the ground receiving station the ON lever must be turned to the up position. Upon energizing the entire console by the ON lever, the receivers must be allowed approximately five minutes to warm up, prior to system operation. Each receiver should then be tuned to the corresponding portable transmitter in the back pack. As to periodical adjustments, the sub-carrier discriminators in the console require band edge adjustment and balance adjustment. These adjustments should be made according to the procedure called out in the manufacturer's manual. The Ampex FR1300 tape recorder will also require adjustments, which are called out in the manufacturer's operating manual.

VI TRANSDUCER

The results of the development program bore out clearly a fact that was recognized at the outset of the development program; namely, that the accuracy and utility of the system is limited by the performance of the pressure transducer employed in the mask electronics subsystem. Constraints on size, and the need to measure very low differential pressure (of the order of 20 mm H_2O) led to the use of a transducer with certain performance limitations. The transducer selected is of a design employing a metallic force-collection diaphragm operating in conjunction with a differential transformer pickoff. Two ports in the housing of the transducer are connected to chambers on either side of the diaphragm. The two sections of the transformer form part of a bridge circuit, the other half of which is located in the mask electronics module. Had this network behaved in an ideal manner, the bridge output signal would have varied in amplitude proportional to the differential pressure sensed by the transducer. Due to the effects of hysteresis and eddy current loss, and non-identical characteristics of the two halves of the transducer winding, certain undesirable phase modulation appears in its output. Furthermore, third harmonic distortion contributes additional uncertainty to the output signal.

The consequence of these imperfections is that environmental effects (principally temperature) create shifts in the baseline and scale factor which impose an ultimate limit on system accuracy. Test results typical of the performance achieved are shown in Figures 8 and 9.

VII RECOMMENDATIONS FOR FUTURE WORK

If tests with the equipment at Edgewood Arsenal indicate that the instrumented protective masks can provide the kind of data which will be useful in advanced mask development, consideration should be given to completing the complement of portable equipment sets to a total of ten. At the same time, however, the advantages of manufacturing an additional quantity of mask sets of established design should be weighed against the improved performance that could certainly be achieved if an improved transducer were employed. Unfortunately, there is no indication that a miniature pressure sensing element of acceptable size and precision has been developed within the community of transducer manufacturers. However, the art has advanced to the point where a suitable device could be developed. For example, considerable attention has been focused on miniature semiconductor strain gage devices. The most attractive aspect of these components is that very simple electronics circuitry can be employed in completing a link from the transducer to the voltage-controlled oscillators employed in standard FM telemetry. This simplicity stems from the fact that the transducer behaves as a resistive bridge. The phase modulation, third harmonic distortion, and severe temperature effects characteristic of miniature inductive pickoffs is eliminated. It appears that end-to-end system accuracy of two to three percent, together with a reduction in the size and weight of mask born electronics, could be achieved with the successful development of a transducer of this type.

APPENDIX A

REV SYM	EO NUMBER	DESCRIPTION	APPROVAL
—	——	PRODUCTION RELEASE	3-5-64 GH

BATTERY CHARGING PROCEDURE

FOR

BACK PACK TRANSMITTER

CONTRACT DA18-108-AMC-228(A)

PREPARED BY		
DESIGN	GH	8-5-64
PROJ ENG		
ENG		
NEXT ASSY	FINAL ASSY	

Spacelabs, Inc.

15521 LANARK ST.
VAN NUYS CALIFORNIA

DWG NO	REV
102525	

SHEET 1 OF 2

Battery Charging Procedure (Nickel Cadmium)

a. Set up a conventional power supply which has constant current capability to at least 0.6 amp and voltage range to at least 40 volts DC.

b. Connect Battery Charging Cable. (Dwg. No. 102665) to power supply. DO NOT CONNECT charging cable to back pack at this point.

c. Set supply to voltage regulate and adjust voltage for 38 VDC.

d. Set supply to current regulate and adjust current setting for approximately 200 ma.

e. Connect charging cable connector to the battery charging connector on the back pack. DO NOT CHARGE while back pack power switch is on.

f. Set the charging current to 560 ma as indicated on the current meter. Allow 14 hours for complete charging.

Mercury Battery

The small MN 9100 cell inside the back pack is for use when the system is operated in the "Hard Wire" configuration. The battery is open circuited until the puck is connected to the back pack at the puck connector. This mercury cell is not rechargable and should be replaced when the voltage drops below 1.2 VDC.

102525

APPENDIX B

REVISIONS

DISPOSITION CODE: 1 MAY BE REWORKED 2 CANNOT BE REWKD. 3 RECORD CHANGE 4 NOW SHOP PRACTICE 5 PARTS MADE OK

REV SYM	WORD CODE	DESCRIPTION	MFG EFF	DISP CODE PART	DISP CODE ASSY	APPROVAL & DATE
		[illegible]				[illegible]

[illegible]

[illegible] 108 AM [illegible]

[illegible]

[illegible]

D[illegible]

			TITLE	Spacelabs, Inc. 15521 LANARK ST. VAN NUYS, CALIFORNIA
DRAFT	P[illegible]	[illegible]		
DESIGNER				
STRESS & WEIGHT				
CHECKER	[illegible]			
DESIGN ENG	[illegible]			
MFG ENG				DWG NO 102242
STDS ENG				REV
PROJ ENG	[illegible]	[illegible]	LAYOUT; RELEASE DATE	
			SCALE —; WT ACT LB; WT CALC LB	SHEET 1 OF 4

General

The mask electronics consists of the following submodules:

a. 40 kc oscillator and power driver.

b. Bridge and amplifier.

c. Bridge and high gain amplifier.

d. Phase sensitive detector. (2)

e. 3.0 kc voltage controlled oscillator.

f. 3.9 kc voltage controlled oscillator.

g. 3.0 kc and 3.9 kc filters

h. Antenna coil driver.

Drawing No. 102226 shows the relationship of the submodules and indicates the signal flow.

Adjustments (Reference Drawing No. 101758)

The two gain adjustments and the oscillator frequency adjustment are factory adjusted and sealed. DO NOT ATTEMPT TO ADJUST THESE POTENTIOMETERS.

Four adjustments are provided to permit bridge balancing, and are indicated on the referenced drawing.

Balancing

The following method is general and applies to both channels. The test points in parenthesis refer to the 3.0 kc oronasal pressure channel.

Test points are related to function as follows:

TP1 D.C. control voltage to 3.9 kc mask pressure channel

TP2 Amplifier output to detector: 3.9 kc mask pressure channel

TP3 Amplifier output to detector: 3.0 kc oronasal pressure channel

TP4 D.C. control voltage to 3.0 kc oronasal pressure channel

a. Connect an oscilloscope to TP2 (TP3), and set sensitivity to 100 mv/cm with a sweep speed of approximately 5 microseconds/cm.

b. Connect a d.c. voltmeter (1 megohm input impedance minimum) to TP1 (TP4).

c. Adjust B1 and B2 (B3 and B4) for minimum amplitude at TP2 (TP3) and 0 $\pm$ 10 mv d.c. at TP1 (TP4). Disregard the harmonic content and magnitude of the waveform at TP2 (TP3).

This completes the balancing procedure; electronics is ready for use.

Scale Factor Check

Following the balancing procedures, pressurize the 1/10 psi transducer to 25 mm H_2O. D.C. output at TP4 should read 0.3 $\pm$ 0.02v d.c. Pressurize the 1/4 psi transducer to 200 mm H_2O. D.C. output at TP1 should read 0.3 $\pm$ 0.02 v d.c.

Battery Charging

The battery packs in the gas mask are rechargable nickel-cadmium cells. The +12.15 volt supply consists of nine Sonotone type S126 cells. The -1.3 volt supply consists of one Mallory CD2 cell. Periodic recharging (approximately every four hours at room temperature) is required. The following precautions should be observed.

a. Use a constant current charging source <u>only</u>.

b. Do not exceed the recommended charge rate.

c. Recharge when the +12.15 volts supply has dropped to 9.5 volts.

d. Recharge the +12.15 volt supply at 20 ma for 14 hours.

e. Recharge the -1.3 volt supply at 5 ma for 14 hours.

A cable is provided for charging purposes.

Accessories

Cables are provided for both access to test points, and battery charging.

Spacelabs, Inc.
March 20, 196[illegible]

Supplement No. 1 to Operating Instructions and General Information for Gas Mark Electronics - Drawing No. [illegible]2212

Battery Charging Procedure

a. Set up two conventional power supplies which have a constant current capability.

b. With lead not connected, set switch to voltage regulate and adjust for 15 VDC. Set the other power supply to voltage regulate and adjust for 3 VDC. Switch both power supplies to the current regulation position.

c. Turn the current adjust fully counterclockwise on each supply. Short the output leads of each supply and set current adjust to zero milliamps.

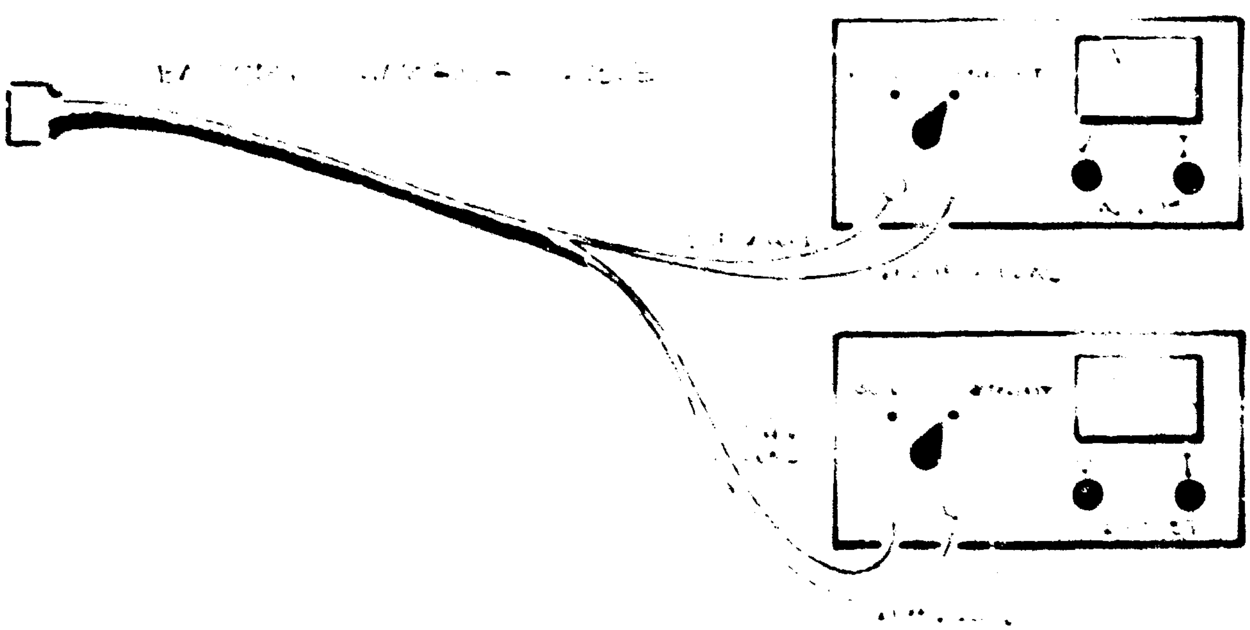
d. Connect the charging cable leads as indicated in the figure.

e. Set the current adjust control for:

(1) 20 ma on the 12.1 V battery

(2) 5 ma on the 1.[illegible] V battery

f. Charge at the above rate for 1[illegible] hours.



4 OF 4

APPENDIX C

DRAFT	
DESIGNER	
STRESS & WEIGHT	
CHECKER	
DESIGN ENG	
MFG ENG	
STDS ENG	
PROJ ENG	

REVISIONS						
DISPOSITION CODE:	1 MAY BE REWORKED	2 CANNOT BE REWKD.	3 RECORD CHANGE			
	4 NOW SHOP PRACTICE	5 PARTS MADE OK		DISP CODE		APPROVAL & DATE
REV SYM	WORD CODE	DESCRIPTION	MFG EFF	PART	ASSY	

Test Procedure
Dynamic Measurements of
Protective Masks, Job 7200

For
U. S. Army Edgewood Arsenal
Edgewood Arsenal, Maryland
Contract No. DA18-108-AMC-228(A)

TITLE	Spacelabs, Inc. 15521 LANARK ST., VAN NUYS, CALIFORNIA	
LAYOUT	RELEASE DATE	DWG NO 7017757	REV
SCALE	WT ACT LB	WT CALC LB	SHEET 1 OF 11

Test Procedure
Dynamic Measurements of Protective Masks, Job 7200

For
U. S. Army Edgewood Arsenal
Edgewood Arsenal, Maryland
Contract No. DA18-108-AMC-228(A)

1.0 SCOPE

1.1 Scope - This procedure establishes the test method, limits and other requirements for the Dynamic Measurements of Protective Masks System manufactured by Spacelabs, Inc. for the Edgewood Arsenal. The test methods, limits, and requirements specified herein are based on the requirements of "Dynamic Measurements of Protective Masks," Contract No. DA18-108-AMC-228(A), Order No. CPS-21835 for the U. S. Army Edgewood Arsenal.

2.0 APPLICABLE DOCUMENTS

Applicability - The following documents, of the issues and dates specified, shall form a part of this procedure only to the extent specified herein.

2.1 Specifications

None

2.1.1 Government

Contract No. DA18-108-AMC-228(A), Order No. CP3-21835 dated 26 June 1963.

2.1.2 Spacelabs, Inc.

Job Order 7200, dated 1 June 1963.
Test Procedure, Ground Receiving Station, No. 101749 dated 29 January 1964.

3.0 REQUIREMENTS

3.1 Equipment Required

(a) Ground Receiving Station tested per Test Procedure No. 101749.

(b) Back-Pack Transmitting Unit.

(c) Protective Mask (M17) outfitted with dynamic measurement electronics.

(d) Bemco environmental test chamber.

(e) Radio equipped vehicle and base station.

(f) Equibar pressure meter (0 - 30 mm Hg).

(g) Digital Voltmeter - Non-Linear Systems Model 484.

(h) Frequency Counter - CMC Model 200C or equivalent.

(i) Oscilloscope - Tektronix Model 502 or equivalent.

(j) Bulk type tape eraser.

(k) Helmet, protective steel.

3.2 Test Procedure

3.2.1 General - The test method is described in detail in the following paragraphs. Data sheets, test set-ups and equipment will be referenced by figure numbers. Limits will be called out on the data sheets where applicable. All tests shall be conducted in strict accordance with this document.

The tests specified herein have been separated into three categories as follows:

(a) Environmental test of mask-back-pack system.

(b) Operational test of mask-back-pack system using test subject at room temperature.

(c) Operational test of mask-back-pack system with test subject remote from the ground receiving station.

3.2.2 Environmental Test of Mask-Back-Pack System

3.2.2.1 Initial Set-up

Assemble the protective mask system and the back-pack system in the Bemco Environmental Chamber as shown in Figure 1 (temperature 70 + 5°F). Turn on the ground receiving station. Be sure to have the batteries in both the protective mask system and back-pack system fully charged at the beginning of the test. Log the time and battery voltages at the start and finish of the test in Figure 2. Do not shut off battery power until this test has been completed unless the elapsed time exceeds 5 hours. Note: The protective mask battery power supplies can be recharged after 5 hours of use. Battery voltages to be measured under load conditions.

	Back-Pack Voltage		Mask Voltage				
Time	+28V	Limits	+10V	Limits	-1.4V	Limits	Remarks
		+32 to +30 V		+11 to +10.4V		-1.37 to -1.30 V	
		+24 V Min		+9.5 V Min		-1.2 V Min	

Figure 2

Cycle the air piston above and below atmospheric pressure several times and then gradually decrease the pressure excursion on each side of atmospheric to zero. This action will normalize the hysteresis in the pressure transducers. Record both discriminator output voltages in Figure 3 (six sheets provided). The above step assumes that the protective mask and back-pack systems have been properly adjusted prior to this test. These adjustments should be made in

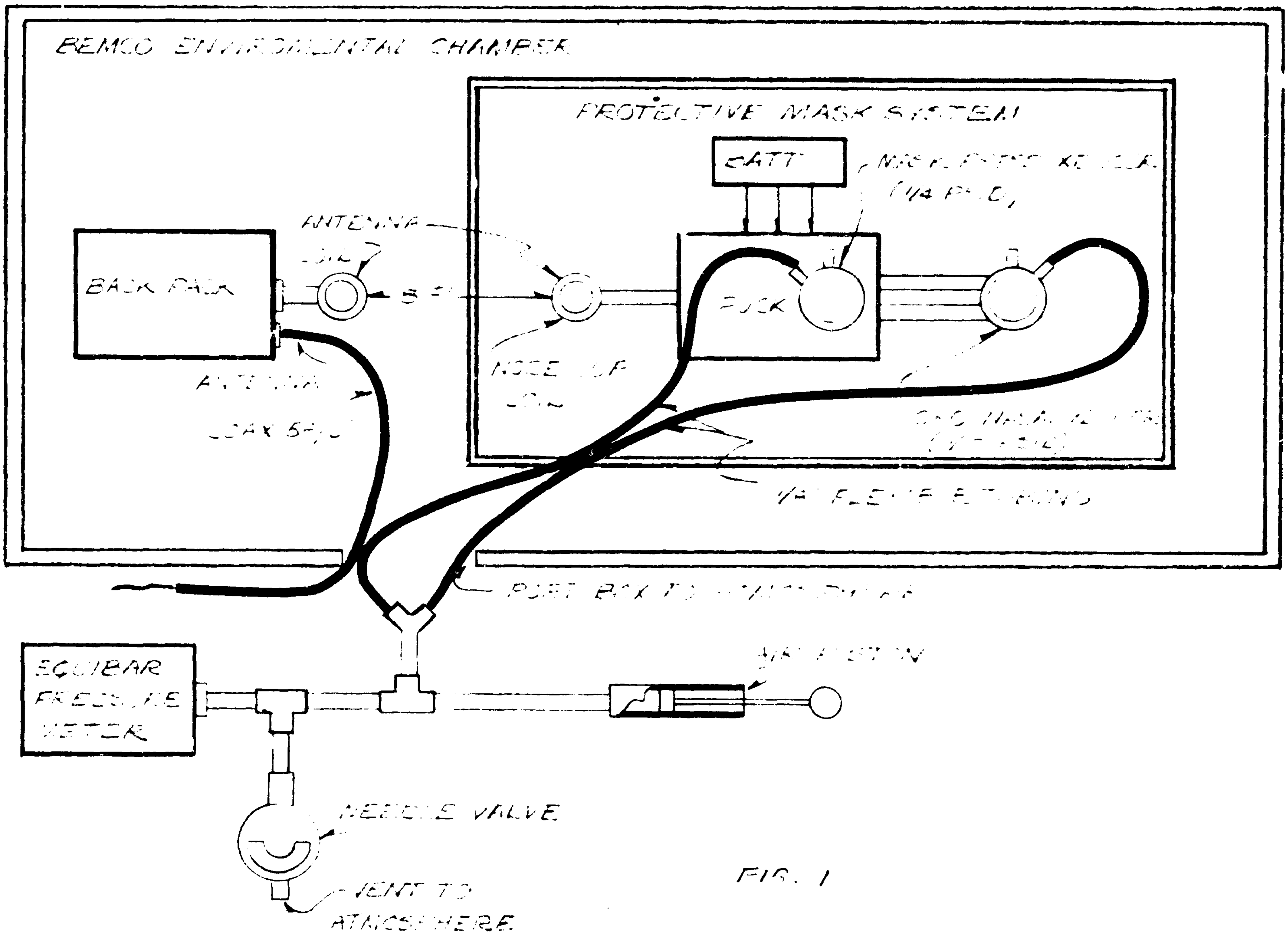

BEMCO ENVIRONMENTAL CHAMBER
PROTECTIVE MASK SYSTEM
BATT
BACK PACK
ANTENNA
PUCK
NEEDLE VALVE
VENT TO ATMOSPHERE

FIG. 1

Transducer & Serial No.	Pressure	Temperature	Discriminator Output Volts	Limits

Figure 3

accordance with the parameters outlined below:

Protective Mask System

Function	VCO Frequency (cps)	Transducer Pressure (mm H_2O)	Percent Deviation	Discriminator Output (Volts)
Oro-Nasal	3000±5	0	0	0±0.15
Oro-Nasal	3225±5	+25	+7.5	-5±0.15
Mask	3900±7	0	0	0±0.15
Mask	3607±7	-200	-7.5	+5±0.15

Back-Pack

Adjust the coupling between the two antenna coils for maximum (see Figure 1). Adjust the composite signal gain control on the back-pack until the subcarrier signal level for each discriminator in the ground receiving station reads 4± 1 volts.

3.2.2.2 Room Temperature Test of Mask Pressure Transducer

Connect the pressure meter and air piston assembly (as shown in Figure 1) to the mask pressure transducer (1/4 psid). Pressurize the mask pressure transducer in accordance with the schedule listed below and record each reading taken in Figure 3. Use conversion table (Figure 5) to convert from mm H_2O to mm Hg. The discriminator output voltage called for in Figure 3 is obtained from the ground receiving station as shown in Figure 4.

0 mm H_2O	-180 mm H_2O	+60 mm H_2O
-10 "	-120 "	+80 "
-20 "	- 40 "	+100 "
-40 "	- 20 "	+60 "
-30 "	- 10 "	+20 "
-120 "	0 "	+10 "
-160 "	+ 10 "	0 "
-180 "	+ 20 "	-10 "
-200 "	+ 40 "	-20 "

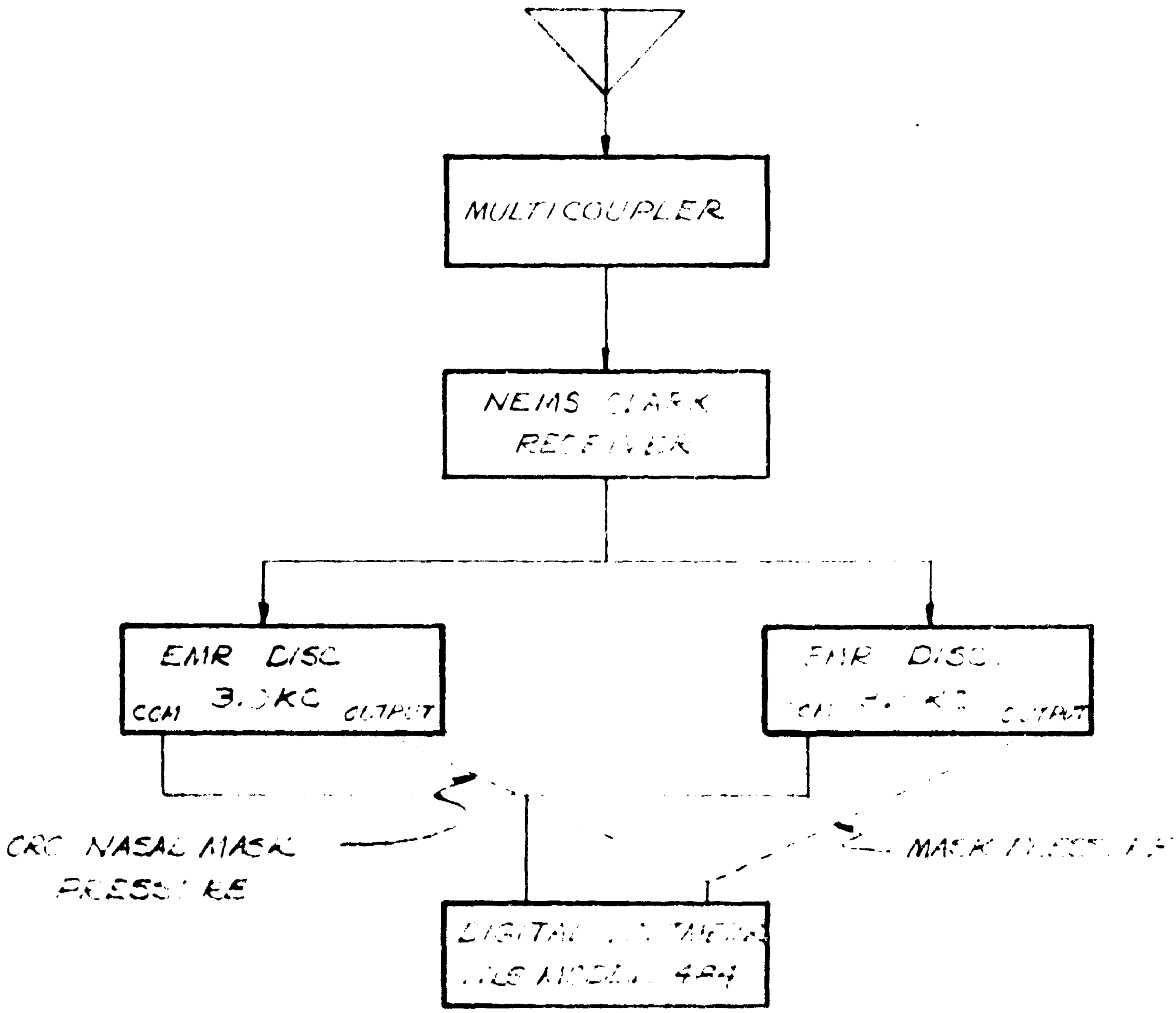


FIG 4

mm H_2O	mm H_g
1	0.0736
2	0.147
3	0.221
4	0.294
5	0.368
6	0.441
7	0.515
8	0.588
9	0.662
10	0.736
11	0.809
12	0.883
13	0.956
14	1.03
15	1.11
16	1.18
17	1.25
18	1.32
19	1.40
20	1.47
21	1.54
22	1.62
23	1.69
24	1.77
25	1.84

mm H_2O	mm Hg
10	0.736
20	1.47
30	2.21
40	2.94
50	3.68
60	4.41
70	5.15
80	5.88
90	6.62
100	7.36
110	8.09
120	8.83
130	9.56
140	10.3
150	11.10
160	11.8
170	12.5
180	13.2
190	14.0
200	14.7

Figure 5

3.2.2.3 Room Temperature Test of Oro-Nasal Mask Pressure Transducer (1/10 psid)

Disconnect the pressure line from the 1/4 psid transducer and connect to the 1/10 psid transducer. Pressurize the 1/10 psid transducer as indicated below and record the data in Figure 3. All operations are similar to steps taken in Paragraph 3.2.2, above.

0 mm H_2O	+20 mm H_2O	-10 mm H_2O
+ 1 "	+10 "	-15 "
+ 2 "	+ 5 "	-20 "
+ 5 "	+ 2 "	-25 "
+10 "	+ 1 "	-20 "
+15 "	0 "	-10 "
+20 "	- 1 "	- 5 "
+25 "	- 2 "	- 1 "
	- 5 "	0 "

3.2.2.4 High Temperature Test of Oro-Nasal Mask Pressure Transducer

With the equipment connected as in the previous paragraph, close the lid on the Bemco Environmental Test Chamber and adjust for +90°F. Let the equipment soak for one hour at this temperature and then repeat the steps called for in Paragraph 3.2.2.3 and record all data in Figure 3.

3.2.2.5 High Temperature Test of Mask Pressure Transducer

Hold the environmental test chamber temperature at +90°F and disconnect the pressure line from the 1/10 psid transducer and connect to the 1/4 psid transducer. Pressurize the 1/4 psid transducer in accordance with the list in Paragraph 3.2.2.2. Record the data in Figure 3.

3.2.2.5 Low Temperature Test of Mask Pressure Transducer

Set the Bemco Environmental Test Chamber controls for 0°F. Let the equipment soak at 0°F for one hour. Repeat the steps in the paragraph above and record the data in Figure 3.

3.2.2.6 Low Temperature Test of Oro-Nasal Mask Pressure Transducer

Keep the environmental test chamber at 0°F and exchange the pressure line from the 1/4 psid transducer to the 1/10 psid

transducer. Pressurize the 1/10 psid transducer as called out in Paragraph 3.2.2.3 and record the data in Figure 3. At the completion of this test, set the test chamber temperature to +90°F and let equipment soak for 15 minutes before opening the test chamber door.

3.2.3 Operational Test of Protective Mask-Back-Pack System

3.2.3.1 Installation and Adjustment

Remove the equipment from the Bemco Environmental Test Chamber and recharge all batteries if required. Install the equipment on a test subject. After installation, adjust the straps on the steel helmet and place on test subjects head. The complete installation shall be under the direction of the cognizant government representatove to ensure that the equipment is positioned as it will normally be used during field tests.

Calibrate both channels of the Brush Recorder so that 20 chart divisions corresponds to 5 volts. Adjust the pen bias so the trace is centered on the chart paper (it is assumed that the discriminators have been previously scale-factored so that 7-1/2 per cent deviation corresponds to 5 volts output). The scale factor at the Brush Recorder has been adjusted so that 20 divisions = 50 mm H_2O on the 3 kc channel and 20 divisions = 200 mm H_2O on the 3.9 kc channel.

3.2.3.2 Operational Test

With the equipment adjusted as above, have the test subject walk or run in place while recording the data transmitted on the Brush Recorder. Mark the chart record as to date, time, and kind of test taken. Paste a tape record reproduction on clean white bond and include as part of the test data. Make any other tests which are recommended by the cognizant government representative.

3.2.4 Operational Test of Protective Mask System with Subject Remote from Ground Receiving Station

3.2.4.1 General

This test is designed to prove that it is possible to transmit data gathered by the protective mask system and to receive and record this data at a remote receiving station. The air line distance between the transmitter and receiver shall be 1000 yards minimum under varying conditions of terrain and ground cover.

3.2.4.2 Method

Recharge all batteries in the protective mask measuring system prior to the start of this test.

Instrument a test subject as described in Paragraph 3.2.3. Calibrate the ground receiving station so that 5 volts out of the discriminator corresponds to 50 mm H_2O and 200 mm H_2O respectively. Drive the test subject, cognizant government representative, and Spacelabs' representative in a two-way radio equipped vehicle to specific areas which will be designated by the government representative as being typical of those areas normally encountered in actual field tests. Keep in constant radio communication with the base station to indicate the test subject's location. At each location selected, make a recording of the transmitted data and log receiver signal strength, subcarrier amplitude, date and time of day on a test sheet.

Note: If desired by the government representative, all receivers should be tuned to the same frequency and the transmitted data recorded on the tape recorder along with spoken data to identify test conditions. This tape would then become a permanent record of the test.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 General

All equipment, components thereof, and test apparatus used in the performance of the tests specified herein shall be made available for inspection by cognizant government representatives who are involved with the testing of this system. All tests specified shall be conducted by the Contractor under surveillance of authorized representatives of the Procuring Activity.

4.2 Test Apparatus and Procedures

The tests and equipment specified herein shall be considered basic. Any additional equipment required to adequately test the item can be added during the performance of the test. This shall include any additional tests or changes in the stated tests, provided the changes are in the best interest of the Procuring Activity. Any changes in this procedure shall be documented and included as an Appendix.

4.2.1 Instrument Calibration

Each item of apparatus upon which the accuracy of the test results depend shall be calibrated at sufficiently frequent intervals to assure attainment of a steady-state accuracy of $\pm$ 3 per cent of the specified value of measurement, except as follows:

(a) Frequency Counter - Stability $\pm$ 1 count

(b) Digital Voltmeter - $\pm$ 0.01% $\pm$ 1 digit

4.3 Test Conditions

All inspections and tests, unless otherwise specified, shall be conducted at prevailing test facility ambient temperature, humidity and atmospheric pressure.

ISSUE DATA

Issue	Date	Job No.	Prepared by	Approved by
S/L No. 101757	2-4-64	7200	H. R. Seal	Project Engineer
				Ch. Proj. Engineer
				Technical Director
				Cognizant Gov't. Representative

APPENDIX D

DISPOSITION CODE:	1 MAY BE REWORKED	2 CANNOT BE REWKD.	3 RECORD CHANGE
	4 NOW SHOP PRACTICE	5 PARTS MADE OK	

REV SYM	WORD CODE	DESCRIPTION	MFG EFF	DISP CODE PART	DISP CODE ASSY	APPROVAL & DATE

SPACELABS NO. [illegible]

TEST PROCEDURE
GROUND RECEIVING STATION, [illegible]

[illegible]

U.S. ARMY EDGEWOOD ARSENAL
EDGEWOOD ARSENAL, MARYLAND

CONTRACT NO. DA[illegible]-AM[illegible] (A)

DRAFT	RT	1-29-64	TITLE: TEST PROCEDURE GROUND RECEIVING STATION	Spacelabs, Inc. 15521 LANARK ST., VAN NUYS, CALIFORNIA
DESIGNER				
STRESS & WEIGHT				
CHECKER				
DESIGN ENG				
MFG ENG				DWG NO 101749
STDS ENG			LAYOUT / RELEASE DATE	REV
PROJ ENG				
	[illegible signature]	1-31-64	SCALE / WT ACT LB / WT CALC LB	SHEET 1 OF 13

S/L No. 101749
29 January 1964

Test Procedure
Ground Receiving Station, Job 7200

For
U. S. Army Edgewood Arsenal
Edgewood Arsenal, Maryland
Contract No. DA-18-108-AMC-228(A)

1. SCOPE

1.1 Scope - This procedure establishes the test method, limits and other requirements for the Ground Receiving Station manufactured by Spacelabs, Inc. for the Edgewood Arsenal. The test method, limits and requirements specified herein are based on the requirements of "Dynamic Measurements of Protective Masks," Contract No. DA18-108-AMC-228(A), Order No. CP3-21835 for U. S. Army Edgewood Arsenal.

2. APPLICABLE DOCUMENTS

Applicability - The following documents, of the issues and dates specified, shall form a part of this procedure only to the extent specified herein:

2.1 Specifications

None

2.1.1 Government

Contract No. DA18-108-AMC-228(A)
Order No. CP3-21835 dated 26 June 1963

2.1.2 Spacelabs, Inc.

Job Order 7200, dated 1 June 1963

3. REQUIREMENTS

3.1 Equipment Required

(a) Transmitter, Teledynamics Model 1061

(b) Digital Voltmeter, Non-Linear Systems Model 484

(c) Power Supply, Harrison Labs. Model 865B

(d) Battery Supply, +28 vdc w/650 mah capacity

(e) Frequency Counter, CMC Model 200c or equivalent

(f) RF Shield Room, Shieldings Inc. or equivalent

(g) Oscilloscope, Tektronix Model 502 or equivalent

3.2 Definition of Test Objectives and Responsibilities - This procedure defines a test method suitable for Government acceptance of system limits and operation. This system (Ground Receiving Station) has been fabricated, to the greater extent, using standard catalog equipment and includes both Government Furnished Equipment and Spacelabs Furnished Equipment. The data will be taken as detailed herein and limits of acceptance or rejection shall be based upon applicable catalog specifications, as called out herein. Spacelabs assumes system responsibility for all equipment furnished to the extent of the published equipment specifications for the catalog items but responsibility for Government Furnished Equipment remains with the Government unless duly authorized to assume this responsibility.

3.2.1 Government Furnished Equipment

(a) Tape Recorder, Ampex Model FR1300

(b) Power Supply, EMR Model 223B

(c) Discriminator, EMR Model 210A

(d) Discriminator, EMR Model 210A

(e) Rack Adapter, EMR Model 222A

(f) Reference Oscillator, EMR 226A

(g) Filler Panel, EMR Model 222

(h) Filter, EMR Model Model 210C

(i) Filter, EMR Model 210C

(j) Channel Selector, EMR Model 210B

(k) Channel Selector, EMR Model 210B

(l) Strip Chart Recorder, Brush Model RD262200

(m) Amplifier, Brush Model RD561200

(n) Amplifier, Brush Model RD561211

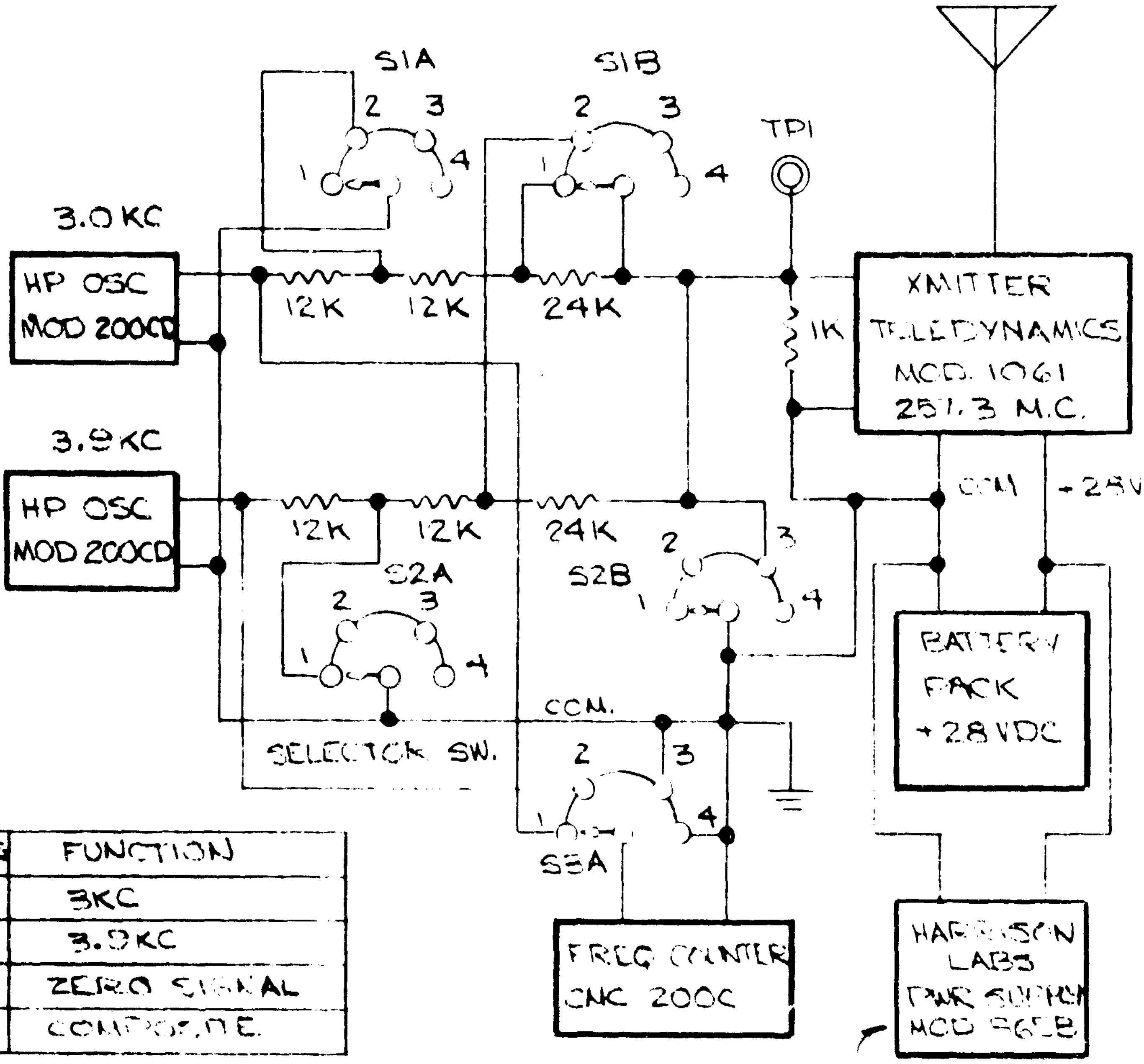
3.3 Test Procedure

3.3.1 General - The test method will be described in detail in the following paragraphs. Data sheets will be referenced and limits stated where applicable. All test equipment and test set-ups will be shown by Figure No. and each test shall be conducted in strict accordance with this documentation.

3.3.2 R.F. Shield Room Test Set-Up - Assemble the test equipment as shown in Figure 1. The objective is to provide an RF carrier signal of variable signal strength which is frequency modulated by precision sub-carrier frequencies. The variable RF signal strength feature is accomplished by attenuating the transmitted signal by closing the screen-room door in addition to trimming the transmitter antenna to a short length. The signal strength as received by antenna No. 2, Figure 2, is shown on the receiver signal strength meter which is marked in units of microvolts per meter. The receiver shall be tuned to the center of the RF carrier signal for all signal strength readings. The signal strength desired and deviation of the RF carrier will be called out in later paragraphs of this procedure.

3.3.3 Ground Receiving Station - The ground receiving station shall be monitored as shown in Figure 2.

3.3.3.1 Initial Set-Up - Turn on the ground receiving system and Hewlitt Packard Oscillators, Model 200CD. Allow one hour warm-up time. After one hour, turn on the equipment in the RF shield room. Set the selector switch to zero and adjust the door and transmitting antenna until receiver #1 in the ground receiving system indicates 1000 $\pm$ 500 on the signal strength meter. Set the selector switch to the 3KC position and set oscillator amplitude control fully clockwise. Now set the frequency to 3000 $\pm$ 1 cps. Adjust the amplitude control for 2 volts peak-to-peak at TPI. Turn selector switch to 3.9KC and repeat procedure above.



SW POS	FUNCTION
1	3KC
2	3.9KC
3	ZERO SIGNAL
4	COMPOSITE

NOTE:
SET CURRENT
LIMIT TO [illegible]00 mA
· VOLTS OUT TO
35 VDC

FIG 1

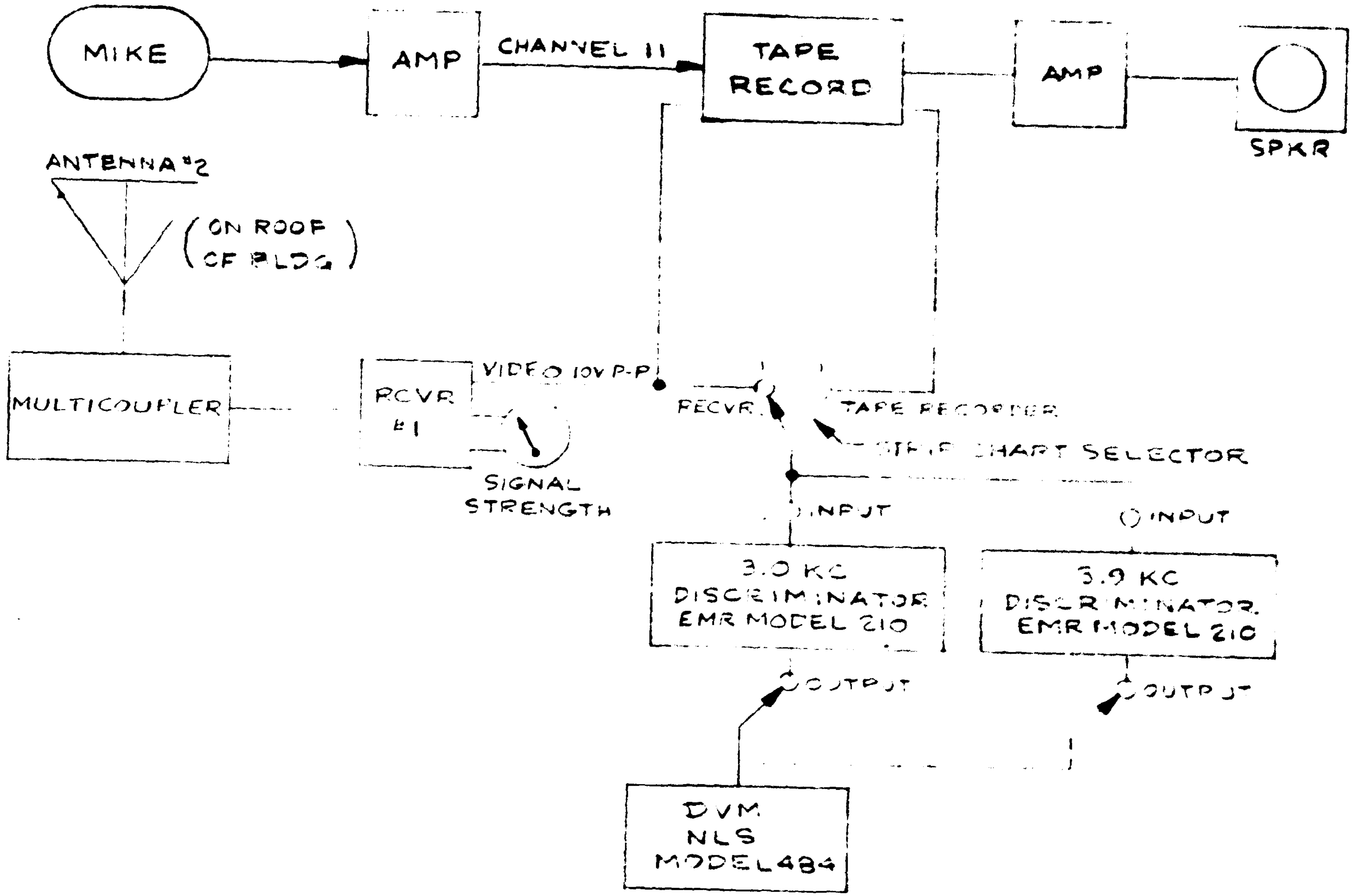

MIKE
AMP
CHANNEL 11
TAPE RECORD
AMP
SPKR
ANTENNA #2
(ON ROOF OF BLDG)
MULTICOUPLER
RCVR #1
VIDEO 10V P-P
SIGNAL STRENGTH
RECVR
TAPE RECORDER
STRIP CHART SELECTOR
INPUT
3.0 KC DISCRIMINATOR EMR MODEL 210
OUTPUT
INPUT
3.9 KC DISCRIMINATOR EMR MODEL 210
OUTPUT
DVM NLS MODEL 484

FIGURE 2

3.3.3.4 Tape Recorder Test - Install a reel of tape (bulk erased) in the FR1300 tape recorder (see Instruction Manual). Turn the tape recorder power switch ON but do not press any other buttons. The power switch will energize the direct record electronics and permit the gain to be adjusted for each channel.

Turn all of the direct record amplifier "Record Level" potentiometers completely counter-clockwise.

Energize the equipment located in the RF shield room per instructions in paragraph 3.3.3.3 (composite signal). Monitor the "Direct Reproduce" signal output on 502 oscilloscope and for each of the ten (10) channels while advancing the direct record "Record Level" potentiometers clockwise until a 2.0 volts peak-to-peak composite signal is displayed on the oscilloscope. Adjust all ten (10) channels for identical operation. The tape recorder must be placed in a "Record" status for these adjustments.

Connect the voice record-reproduce system into Channel 11 of the tape recorder (see Figure 2). Put the tape recorder in a "Record" status and check for proper voice reproduction.

The next test will consist of varying the HP oscillators from center frequency to the + 7.5% bandedges as called out in Figure 3. A three point calibration will be used to test the tape recording system.

Set the two oscillators to the upper bandedge (+ 7.5%). When the frequency counter indicates that both oscillators are at upper bandedge, place the tape recorder in "Record" status and indicate both frequencies by voice recording. Record constantly for a minimum of 15 minutes and stop the tape. Now adjust both oscillators to center frequency and repeat as above. Adjust the oscillators to lower bandedge (-7.5%) and again repeat the above. Be sure to indicate all steps taken by voice recording. This will permit positive identification of each test frequency on the tape.

Rewind the tape to the starting point and place the tape recorder in a "Reproduce" status.

Rotate the strip chart selector switch through each of the ten (10) tape recorder playback positions. At each position, record the output voltage (using a digital voltmeter) obtained at each of the two EMR discriminator outputs. Log this data in Figure 6. The readings taken in Figure 6 should closely correspond to the data taken in Figure 3 for like frequency settings.

Center Freq. CPS	% Dev.	Freq.	Discr. Output Volts	True Reading	% Error
3000	0	3000	0.0000 ± 1	0.000	
3000	+1	3030		1.000	
3000	+2	3060		2.000	
3000	+3	3090		3.000	
3000	+4	3120		4.000	
3000	+5	3150		5.000	
3000	+6	3180		6.000	
3000	+7	3210		7.000	
3000	+7.5	3225	Adjust for 7.500 volts	7.500	
3000	-1	2970		1.000	
3000	-2	2940		2.000	
3000	-3	2910		3.000	
3000	-4	2880		4.000	
3000	-5	2850		5.000	
3000	-6	2820		6.000	
3000	-7	2790		7.000	
3000	-7.5	2775		7.500	
3900	0	3900		0	
3900	+1	3939		1.000	
3900	+2	3978		2.000	
3900	+3	4017		3.000	
3900	+4	4056		4.000	
3900	+5	4095		5.000	
3900	+6	4134		6.000	
3900	+7	4173		7.000	
3900	+7.5	4192.5	Adjust for 7.500 volts	7.500	
3900	-1	3861		1.000	
3900	-2	3822		2.000	
3900	-3	3783		3.000	
3900	-4	3744		4.000	
3900	-5	3705		5.000	
3900	-6	3666		6.000	
3900	-7	3627		7.000	
3900	-7.5	3607.5		7.500	

FIGURE 3

3.3.3.2 <u>3KC Discriminator Channel</u> - With the applicable HP oscillator set to 3000 ± 1 cps, and the selector switch set to the 3KC position, adjust the balance control on the EMR discriminator channel selector so the output voltage reads 0.000 ± 0.001 (see Figure 3). Now vary the oscillator frequency as required to obtain the data required in Figure 3. Record the output voltage and polarity for each frequency listed in Figure 3.

3.3.3.2.1 <u>3.9KC Discriminator Channel</u> - Repeat the above procedure for the 3.9KC channel and record the data obtained in Figure 2. The data collected in Figure 3 shows the accuracy and linearity of the two EMR discriminator channels. This equipment will be used as a reference standard after a three point calibration for all future tests provided the collected data complies with the published specifications for this equipment.

3.3.3.3 <u>Receiver Test (10 ea.)</u> - Turn the selector switch to zero with the transmitter energized as above. Tune all ten (10) receivers to 257.3 mc and record the individual signal strength readings in Figure 4. Now set the selector switch to 3KC and record all ten (10) receiver video outputs in Figure 4.

Receiver Number	Signal Strength µv/meter	Acceptance Limits µv/meter	Video Signal Amplitude P-P	Accept. Limits	Composite Signal Ampl. P-P
1 (Basic)		Basic ± 100		Basic ± 3V	
2					
3					
4					
5					
6					
7					
8					
9					
10		Basic ± 100		Basic ± 3V	

FIGURE 4

Turn the selector switch to composite and record amplitude of composite video signal from each receiver in Figure 4. There should not be any significant variation between receivers from the data previously recorded.

With the selector switch on composite and the HP oscillators set to their respective center frequencies (3000 and 3900 cps), turn the strip chart selector switch on the video (receiver) control panel through positions 1 to 10 and monitor the output of both discriminators to see that they are at zero volts output. Record the actual voltages indicated in Figure 5.

Receiver Number	EMR 3.0KC Discrim.		EMR 3.9KC Discrim.	
	Reading	Acceptance	Reading	Acceptance
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

NOTE:

Acceptance values to be determined by Government Representative.

FIGURE 5

H.P. Osc. Frequency	EMR Discriminator Output Volts									
	1	2	3	4	5	6	7	8	9	10
3225										
4192.5										
3000										
3900										
2775										
3607.5										

FIGURE 6

4. QUALITY ASSURANCE PROVISIONS

4.1 General - All equipment, components thereof, and test apparatus used in the performance of the tests specified herein shall be made available for inspection by cognizant Government Representatives who are involved with the testing of this system. All tests specified shall be conducted by the Contractor under surveillance of authorized representatives of the Procuring Activity.

4.2 Test Apparatus and Procedures - The tests and equipment specified herein shall be considered basic. Any additional equipment required to adequately test the item can be added during the performance of the test. This shall include any additional tests or changes in the stated tests, provided the changes are in the best interest of the Procuring Activity. Any changes in this procedure shall be documented and included as an Appendix.

4.2.1 Instrument Calibration - Each item of apparatus upon which the accuracy of the test results depend shall be calibrated at sufficiently frequent intervals to assure attainment of a steady-state accuracy of plus or minus 3 percent of the specified value of measurement, except as follows:

(a) Frequency Counter - Stability $\pm$ 1 count

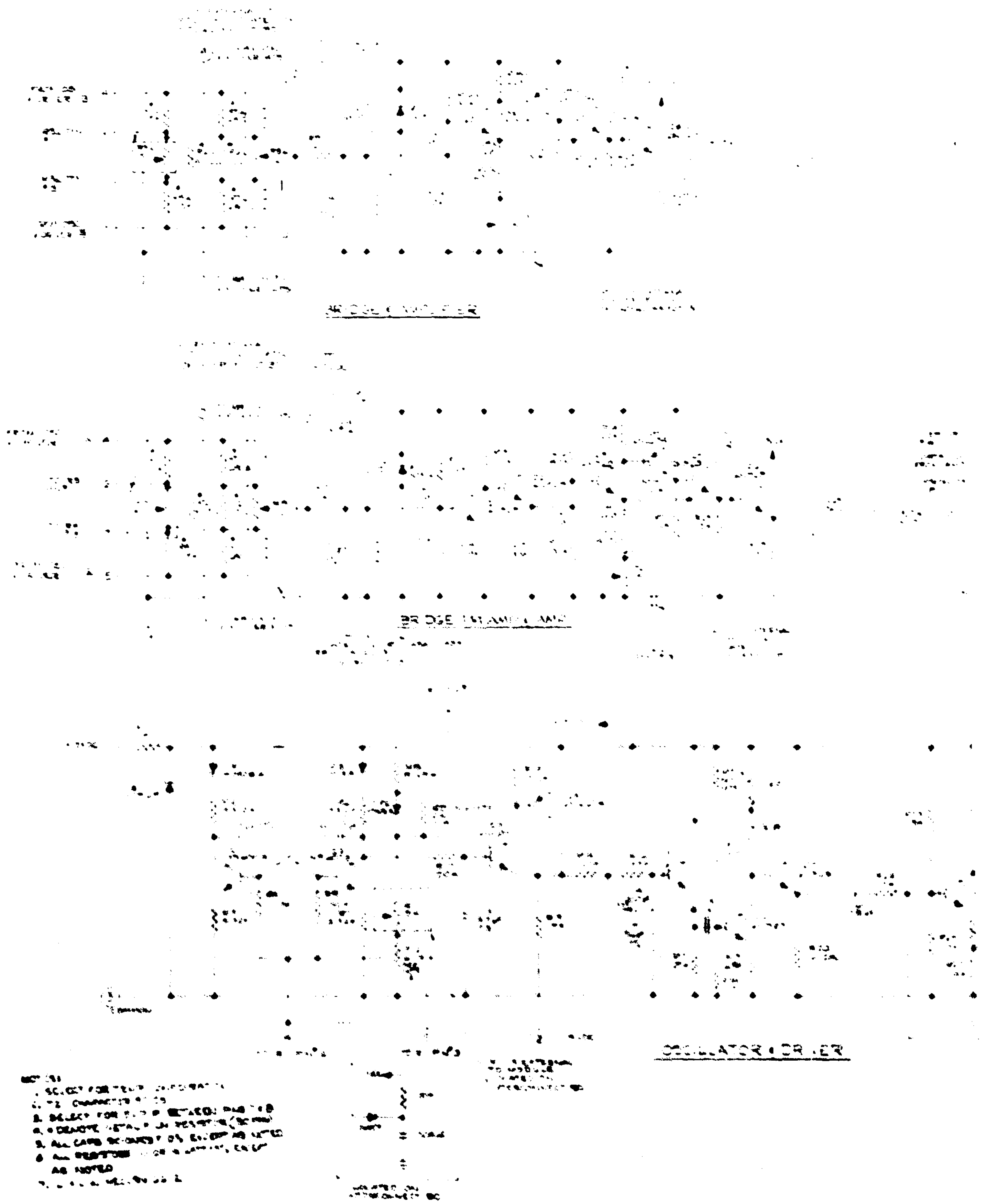
(b) Digital Voltmeter - $\pm$ 0.01% $\pm$ 1 digit

4.3 Test Conditions - All inspections and tests, unless otherwise specified, shall be conducted at prevailing test facility ambient temperature, humidity and atmospheric pressure.

ISSUE DATA

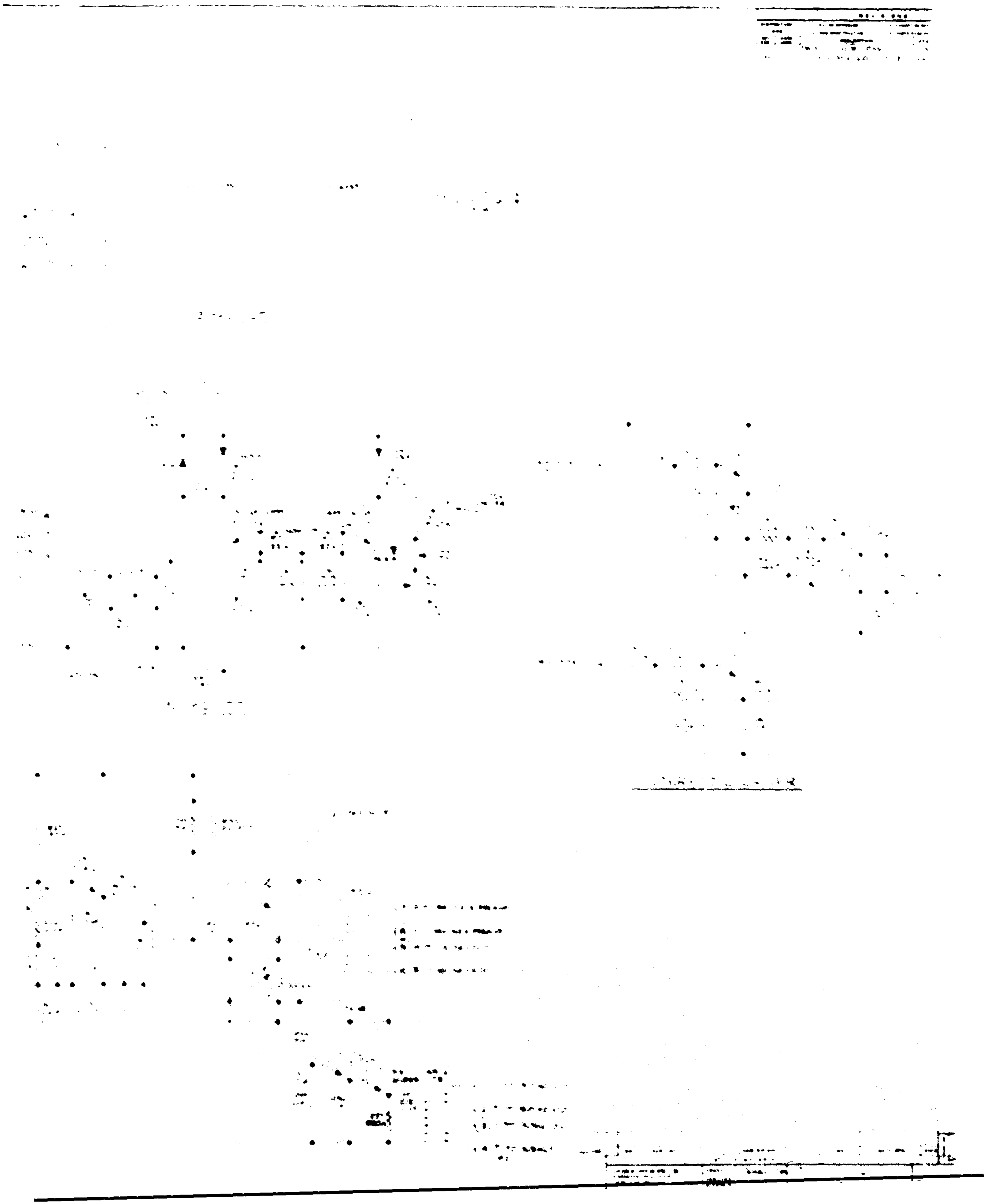
Issue	Date	Job No.	Prepared by	Approved by
S/L No. 101749	1-29-64	7200	H. R. Seal	Project Engineer Ch. Proj. Engineer Technical Director Cognizant Gov't. Representative

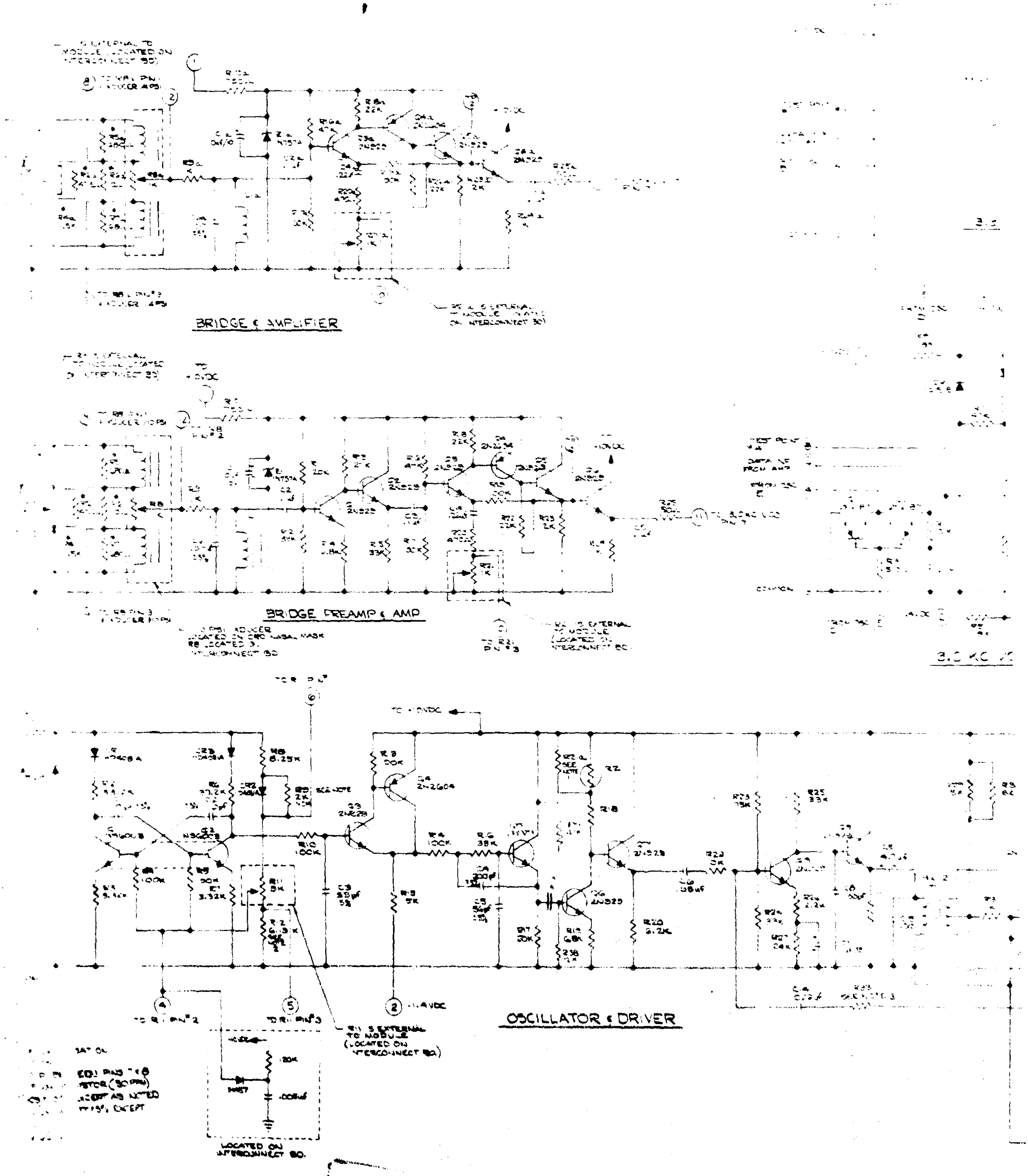
APPENDIX E



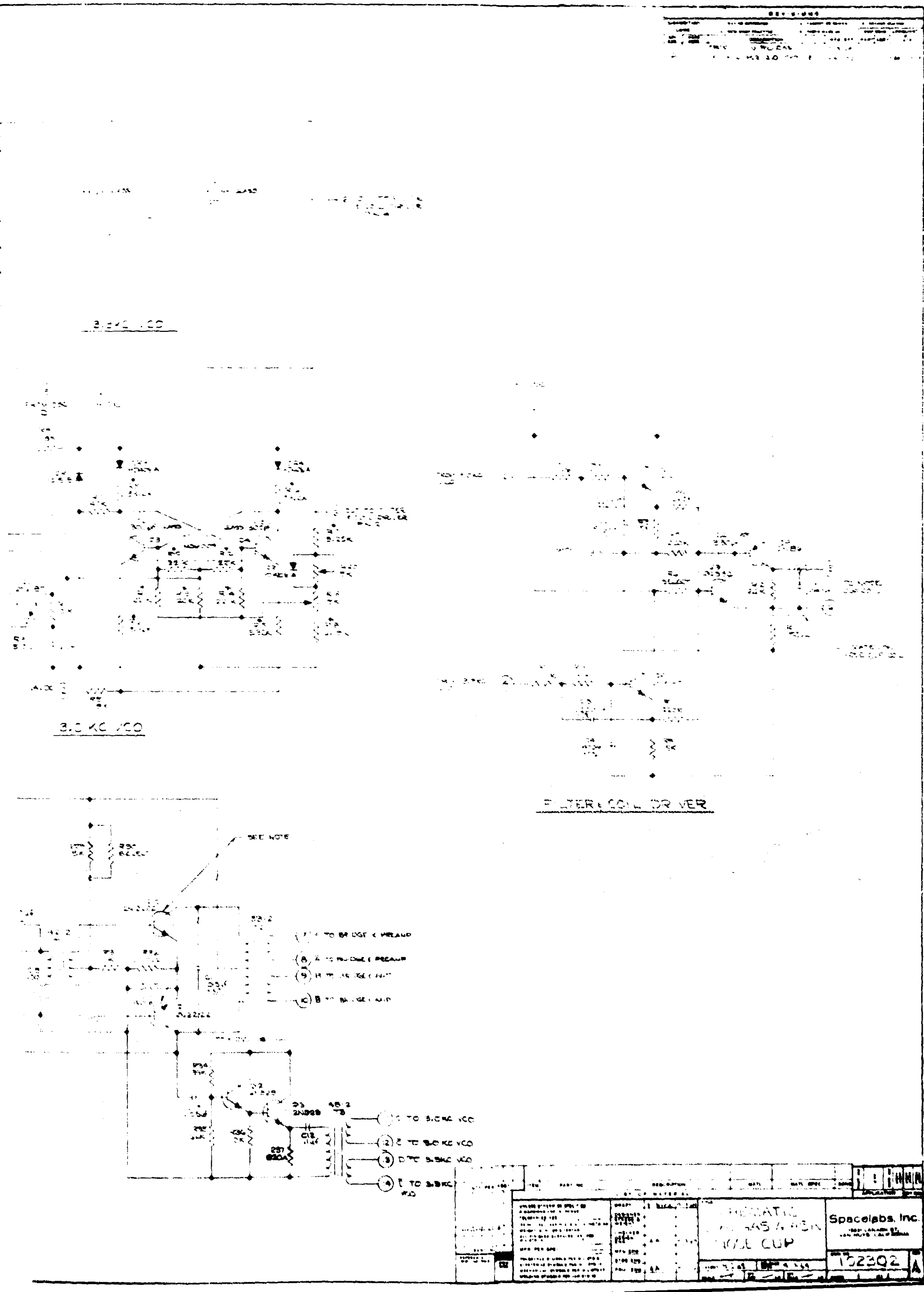
NOTES:

AS NOTED




BRIDGE & AMPLIFIER
BRIDGE PREAMP & AMP
OSCILLATOR & DRIVER
LOCATED ON INTERCONNECT BD.

B


3.0 KC VCO
FILTER & COIL DRIVER
SEE NOTE
2N929
2N929
TO BRIDGE & PREAMP
TO BRIDGE & PREAMP
TO 3.0KC VCO
TO 3.9KC VCO
Spacelabs, Inc.
A

APPENDIX F

FM TRANSMITTER SPECIFICATIONS

ELECTRICAL SPECIFICATIONS

The following electrical specifications are maintained with any combination of the specified power input and the environmental conditions:

Power Output: 1.0 watt minimum into a 50-ohm resistive load.

Frequency Range: As specified

Frequency Stability: ± 0.01% of center frequency.

Frequency Deviation: ± 150 kilocycles.

Deviation Sensitivity 1 volt rms (maximum) will produce 150 kc deviation.

Input Impedance: Greater than 25 kilohms

Modulating Frequency Range: Response is flat within ± 3db from 20 cycles to 300 kilocycles.

Distortion: Less than 3.0% at ± 125 kilocycles deviation, 5 kilocycles modulation.

Incidental FM: Less than 5 kilocycles.

Power Input Requirements: 28 volts dc ± 10%, at 550 milliamperes nominal, 650 milliamperes maximum.

Modulation: True FM.

Radio Frequency Interference: Designed to meet the Antenna Conducted, power line and case radiated limits of MIL-I-26600.

Modifications for special requirements are available on special order.

THESE SPECIFICATIONS are based on Tele-Dynamics test procedures, are subject to change without notice, and should be confirmed when ordering.

ENVIRONMENTAL CONDITIONS

Temperature Range: $-40^{\circ}C$ to $+60^{\circ}C$ with heat sink temperature not in excess of $+85^{\circ}C$.

Vibration: 15g peak sine or 15g rms random, 20 to 2000 cps, 10 minutes, along each of 3 mutually perpendicular axes.

Shock: 100g impact shock in each direction of 3 mutually perpendicular axes, each shock 11 milliseconds duration.

Acceleration: 60g for 5 minutes in each direction of 3 mutually perpendicular axes.

Altitude, Humidity, Salt Spray, and Sand and Dust: The unit is enclosed in a sealed case, and is unaffected by these environments.

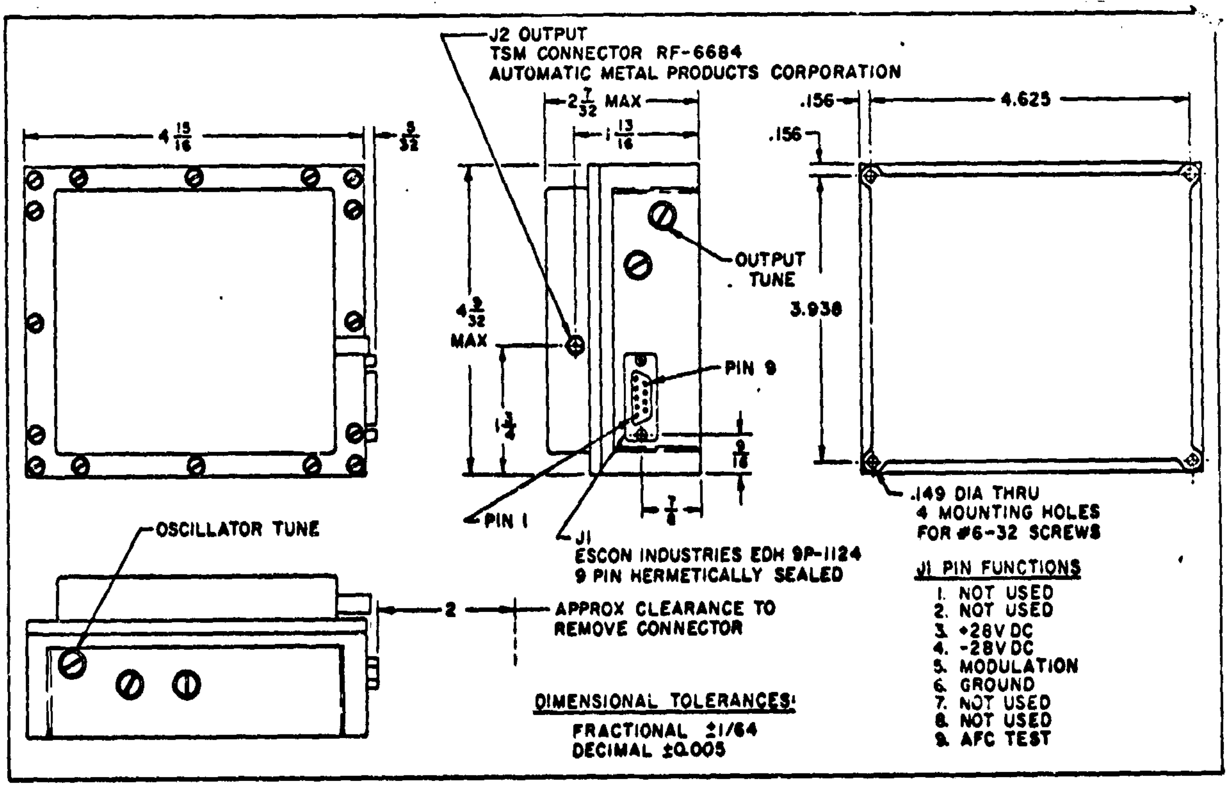
PHYSICAL CHARACTERISTICS

Weight: 38 ounces (approximately)

Connectors: RF output connector, Automatic Metal Products RF-6684, TSM (mates with Automatic Metal Products RF-6621-54 which is supplied with transmitter). Power and signal input connector, Escon Industries EDH-9P-1124, 9-pin hermetically sealed (mates with standard Cannon DE-9S series connector which is supplied with transmitter).

Housing: Pressure-sealed aluminum case with gold finish.

Mounting: Four #6-32 x 1-3/4" long BH stainless steel screws supplied with transmitter.



INSTALLATION NOTES

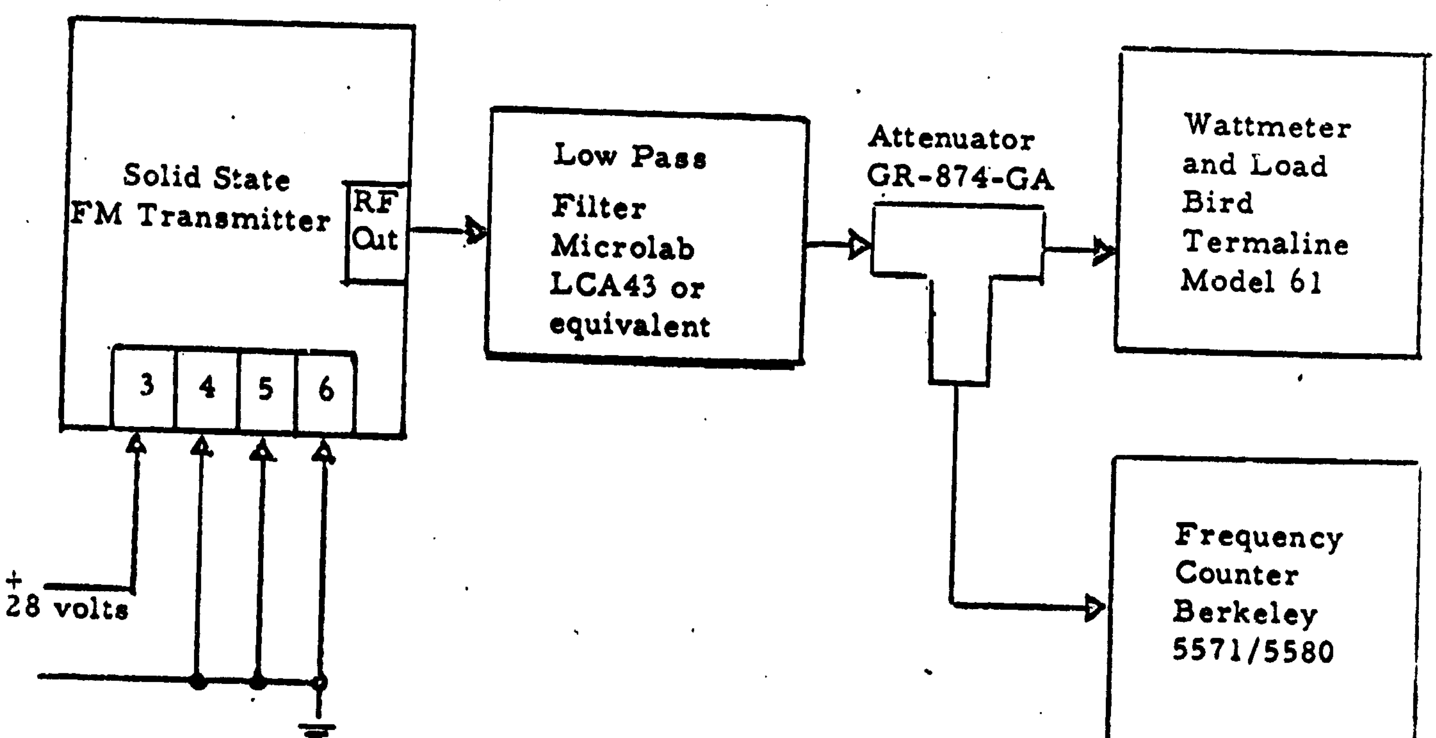
1. Heat sink temperature must not exceed +85°C.
2. Allow approximately 2 inches in front of the power connector for mating connector and cable clearance.
3. Allow sufficient clearance from the front and right-hand side of the case for access to tuning adjustments.

ALIGNMENT

1. Connect the test equipment as shown and allow sufficient warm-up time to stabilize the operation of the frequency counter. Use the alignment tool, JFD No. 5284, supplied with the transmitter, or an equivalent type, to perform the following adjustments. The OSC TUNE control is located at the front of the transmitter and the OUTPUT TUNE control is located on the right-hand side.

2. Observe the output frequency reading on the frequency counter. If necessary, adjust the OSC TUNE control to obtain the specified frequency. As an aid to calibration, the frequency deviation from the nominal nameplate frequency, in kc observed at a standard test condition of 35°C case temperature, is stenciled below the frequency tuning port. To duplicate factory test results, the transmitter should be retuned to this frequency at the standard test conditions. When no marking appears on the transmitter case, the nameplate frequency should be used.

3. Observe the power output reading on the wattmeter and adjust the OUTPUT TUNE control for maximum power output.



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